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CACDA JIFFY WAR GAME TECHNICAL MANUAL PART 1: METHODOLOGY

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Directorate of Combat Operations Analysis
US Army Combined Arms Combat Developments Activity
Fort Leavenworth, Kansas 66027

CACDA JIFFY WAR GAME TECHNICAL MANUAL

Part 1: Methodology

by

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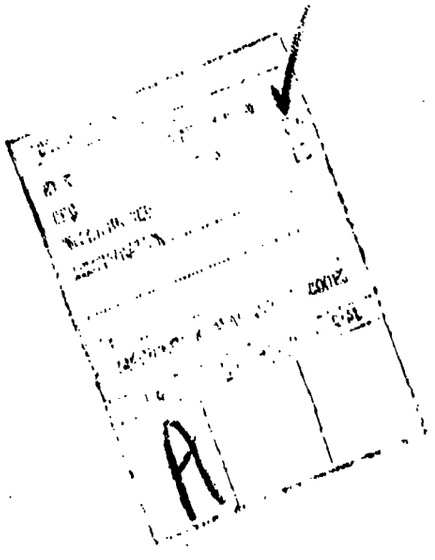

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FOREWORD

The Jiffy Game has existed, as a manual war game, since the late 1960's. In its early stages, the game was completely manual and, correspondingly, its assessment methodology was simplistic, based on the firepower scores of a few key weapon systems. In late 1973, USATRADOC established the Scenario Oriented Recurring Evaluation System (SCORES), the standard scenario development process that was to be based on the Jiffy Game. With the advent of SCORES, it was recognized that the simplistic, firepower score-driven Jiffy Game, although responsive, was not of adequate resolution to produce the quality product expected from SCORES. Thus, the Jiffy Game underwent major methodology modifications, which allowed the gaming of the complete spectrum of conventional weapon systems and upgraded the assessment methodologies to use weapon characteristics instead of firepower scores as the basis for assessments. However, as the level of detail increased, the number of manual calculations and the amount of data required to make the calculations also increased. Finally, it became necessary to automate the assessment calculations to maintain the Jiffy Game's responsiveness. The automation process was completed in May 1975. This methodology was developed principally by MAJ Karl Lowe assisted by LTC Tom Buff, MAJ Ken Nash, and MAJ Bob Riddick, and was documented in July 1975 with the publishing of the USACACDA, SCORES "Jiffy" War Gaming Methodology.

In the fall of 1975, as a quality assurance measure, the Jiffy Game methodology was subjected to sensitivity analysis. A Jiffy Game improvement program was initiated as a result of the analysis. The improvement program consisted basically of three tasks. First, the assessment methodology needed further modification and improvement in certain areas. Second, the capability to maintain on computer files a hierarchy of units consistent with the overall gaming methodology was to be added to the Jiffy Game. Finally, detailed documentation of the revised methodology and all supporting computer programs was to be published. (This report was produced to document the Jiffy Game methodology what resulted from the improvement program.)

The authors of this report wish to acknowledge the SCORES war gaming staff of the Combined Arms Combat Developments Activity (CACDA) who served as consultants during the methodology development. The authors also acknowledge Mr Ronald G. Magee and Mr Clim Curry, who performed the Jiffy Game sensitivity analysis and who had a major influence on the development of the revised methodology. Special thanks are given to Mrs Elizabeth Etheridge, who served as technical editor for this report, and to Miss Laura B. Weishaar, who typed the report.

ABSTRACT

This report is one of a set of three reports produced to document the combat assessment methodologies and automated features of the Combined Arms Combat Developments Activity (CACDA) "Jiffy" war gaming process. This process was developed to support the TRADOC Scenario Oriented Recurring Evaluation System (SCORES) scenario development and force evaluation efforts. Part 1 of this report contains the methodologies used in the automated routines of the Jiffy Game, the computer model run in support of the CACDA "Jiffy" war gaming process. An unclassified data base, which was developed for test and demonstration purposes, is presented in part 1. The classified data used in the Jiffy Game during secure production runs is published separately to keep the methodology volume unclassified. Part 2 of this report presents the Jiffy Game classified data base and the sources from which the data were extracted or derived. The other two reports in the set are the CACDA Jiffy Game Programmers Manual, which consists of descriptions, logic flow diagrams, and the FORTRAN code of all the programs and routines associated with the Jiffy Game; and the CACDA Jiffy Game Users Manual, which contains a discussion of the manual aspects and automated features of the gaming process and a sample of an unclassified run.

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1. SCOPE. This report presents discussions of the methodologies and data used in the Jiffy Game, a computer program that automates the combat assessments of the CACDA "Jiffy" war gaming process. Discussions of the manual aspects of the CACDA "Jiffy" war gaming process may be found in CACDA Jiffy War Game Users Manual and the SCORES "Jiffy" War Gaming Methodology (reference 5). To avoid classifying the methodology discussions in this report, all classified data used in the Jiffy Game are published separately as Part 2.

2. OVERVIEW.

a. General. The CACDA "Jiffy" war gaming process is a computer-assisted, manual war game developed and operated at the USATRADOC Combined Arms Combat Developments Activity (CACDA), Fort Leavenworth, Kansas, for scenario development and force structure evaluation. The Jiffy Game computer model is a two-sided, interactive war game, ~~which is programmed to be~~ oriented toward the nontechnical model operator. This interactive characteristic of the model permits military gamers to interject timely, realistic tactical decisions during the play of the game.

b. Gamer Functions. The manual functions of the CACDA "Jiffy" war gaming process are the aspects of military operations that are associated with doctrine and tactics. The manual functions include the commander's concept of the situation, the allocation of forces, terrain analysis, movement/map maneuver, engage/disengage criteria, and the distribution of personnel and materiel replacements. Some of the functions of the game are automated to remove from the gamers the burden of manually performing the many tedious, repetitious calculations necessary for these functions. These computerized functions include the rate-of-advance calculations, the combat loss assessment of personnel and materiel, and apportionment of the losses to the combat units.

c. Game Resolution. The CACDA "Jiffy" war gaming process is a low resolution game that is capable of playing virtually any size force but is usually gamed at the corps level. During an application of the model, the corps front is divided into "sectors" in which the rate-of-advance and combat assessment calculations are made. The sectors are typically Blue battalion sized, which corresponds to that portion of the corps front that is the area of operation for a Blue battalion. The unit resolution in the game is generally at the Blue company and Red battalion levels. The rate-of-advance and combat assessments are based on the aggregate of the weapon systems of all Red and Blue combat units in the sector. The length of time during which the combat occurs is known as the "critical incident." Critical incidents (CI) typically last 4 to 6 hours.

3. ASSUMPTIONS AND LIMITATIONS.

a. The Jiffy Game methodologies do not consider any synergistic effects among the different combat assessments; e.g., the fact that an armored vehicle is in a minefield does not have any impact on the assessment of the armored vehicles by the indirect fire combat.

b. Rate of advance is based on firepower scores adjusted for terrain, visibility, and the tactical situation.

c. Line of sight is not played explicitly but was considered in the development of the expected number of engagements for direct fire weapons.

d. Visibility is played both as a decrement to acquisition discriminators which reduce the number of targets at which to fire, and as a restriction to the maximum engagement range for direct fire combat.

e. Suppression is based on firepower scores and is played as a decrement to the number of weapon systems available to fire.

f. No specific unit geometry is played in the Jiffy Game. The combat units in a sector are reduced to characteristic arrays of weapon systems, which engage each other.

g. Weapon systems in one sector cannot engage the weapon systems in another sector.

h. Assessments are generally nonlinear aggregates of one-on-one duels.

i. Dismounted infantry combat casualties are based on firepower scores.

j. Mounted infantry casualties are assessed in proportion to infantry personnel carrier losses. If infantry is mounted, it remains mounted during the entire CI, except for a special case in the indirect fire assessment.

k. Infantry materiel losses are assessed in proportion to infantry personnel casualties.

l. Crews are lost in proportion to crew-served weapon losses.

m. Losses are apportioned to the combat units based on qualitative levels of combat intensity.

n. Ammunition expenditures reflect only the number of rounds fired at the opposing force. They do not include rounds lost to combat damage.

4. FORCE STRUCTURE.

a. General. The Jiffy Game has the capability to game two forces in combat against each other. The forces are composed of basic elements called units. The size of the units vary, but they are generally company or battalion size for the defending force, and the next higher echelon for the attacking force. Units are grouped (task organized) into higher echelon organizations, which are referred to as parent units. During applications of the game, the gamers are able to manipulate the forces at the unit and/or parent unit levels defined for that game.

b. Force Definition. Units are initialized into the forces through a process designed to take advantage of the US Army's concept of Tables of Organization and Equipment (TOE). The process, which is performed before any gaming can begin, involves generating a data base of TOE standard requirements codes (SRCs). The SRCs define the numbers and types of weapon systems found in each specific subunit organization; e.g., an infantry squad or a tank platoon. From the completed SRC data base, each unit is defined by giving it a unique name and specifying all SRCs to be included in it. The units are then task organized into parent units which, as a final step, are loaded into the Red or Blue force. A more detailed discussion of this process may be found in the Programmers Manual, and an example is given in appendix A of the Users Manual.

c. Weapon System Arrays. The Jiffy Game does not process units in the combat assessments but, instead, bases its calculations on aggregates of the weapon systems of the opposing forces in a given sector. All units engaged in combat in a sector are reduced to their individual weapon systems, which are accumulated for each force as arrays of individual weapon systems to oppose each other in combat.

5. RATE OF ADVANCE.

a. General. An attacker rarely advances uniformly; instead, he advances in many short, uneven bounds. The single value for rate of advance determined in the Jiffy Game is the average of these nonuniform bounds over a substantially large period of time. The determination of the rate of advance defines the time-distance relationships for the play of the game. Rate of advance is expressed as either the distance an attacker may expect to advance in a specified time or the amount of time required to advance a specified distance. Rate of advance is affected by both military and environmental factors.

b. Firepower Scores. The rate of advance determined by the Jiffy Game is based on firepower scores. Firepower scores are simply numerical values assigned to weapon systems to quantify their potential to inflict damage. The firepower scores used in the Jiffy Game were derived from the Concepts Analysis Agency's (CAA) Weapon Effectiveness Indices/Weighted Unit Values II (WEI/WUV-II) (reference 4). The Jiffy Game firepower scores are classified and may be found in Part 2, table B-1, appendix B. An unclassified set of

firepower scores, generated for test and demonstration purposes, is given in table 1. The total firepower score of a force is the sum of the firepower scores of all the weapon systems in the force. The total firepower score may be divided into two groups: combat and fire support. The combat firepower score is the cumulative firepower score of all the weapon systems expected to be found in the maneuver elements of the force. They include small arms, ground mounted antitank weapons, armored vehicles, and tanks. The fire support firepower score is the cumulative firepower score of the weapon systems associated with fire support roles. These weapon systems typically include air defense artillery and missiles, field artillery and rockets, mortars, attack helicopters, and tactical aircraft. It should be noted that the firepower scores for the air defense systems can be added into the total firepower score only if the opposing force is employing a significant air threat.

c. Methodology. The data base for expected rates of advance used in the Jiffy Game was developed from historical rate of movement data compiled in the Research Analysis Corporation (RAC) Theater Quick Game Model (TQGM) and Theater Battle Model (TBM-68). The Jiffy Game rate of advance data base is contained in tables 2 through 6. These rates are based on an adjusted force firepower ratio and consider the effects of the tactical situation, attacker mobility, terrain, and visibility.

(1) Firepower ratio. A firepower ratio is a measure of one force's capability to inflict damage relative to the capability of another force. In forming such a ratio, the tactical situation of the maneuver units of both the attacking and the defending forces are considered, and the firepower scores are adjusted accordingly. For instance, a defending force would expect to be less vulnerable if it were occupying a fortified defensive position than if it were engaging the enemy in the open. Likewise, an attacking force would expect to inflict greater damage executing a double envelopment than attacking in a frontal assault. Six types of tactical situations, as described in table 7, can be played in the Jiffy Game. The firepower score adjustment factors for the weapons in the attacker and defender maneuver units for all tactical situations are contained in tables 8 and 9, respectively. The fire support weapon systems are not as sensitive to the tactical situation as those of the maneuver units. Thus, the adjustment factors for all fire support weapons are unity. The unadjusted total firepower score for each force is multiplied by the appropriate tactical situation adjustment factor and the attacker-to-defender firepower ratio is then calculated. The firepower ratio calculation is expressed algebraically as:

$$FPR = \frac{\sum_{all\ i} ATSAF_i \, N_i \, FPS_i}{\sum_{all\ k} DTSAF_k \, N_k \, FPS_k} \qquad (5\text{-}1)$$

Table 1. Unclassified firepower scores.

Weapon System	Firepower Score
Trucks	5
Infantry Personnel	1
Small Arms	1
LAW, RPG-7	5
DRAGON, SPG-9	10
TOW, SAGGER	20
Recoilless Rifles	10
Tanks	100
Heavy Armored Inf Vehicles	75
Heavy Assault Guns	50
Light Armored Vehicles	10
Armored AT Weapons	20
Light Assault Guns	25
ADA Guns	25
Manpack SHORAD Missiles	10
SHORAD Missiles	20
ADA Missiles	25
Mortars	75
Field Artillery	100
Attack Helicopter-1	20
Attack Helicopter-2	40
Attack Helicopter-3	60
Attack Helicopter-4	80
Light Observation Helicopter	10
Transport Helicopter	5
Tactical Aircraft	100

NOTE: See Table B-1 in part 2 of this report for classified firepower scores.

Table 2. Rates of advance for meeting engagements.

Rates of Advance (kilometers per hour)

COMBAT RATIO (ATTACKER: DEFENDER)	A						B						C						D						Terrain
	GOOD		FAIR		POOR		GOOD		FAIR		POOR		GOOD		FAIR		POOR		GOOD		FAIR		POOR		Visibility
	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	Attacker Mobility D=Dismounted M=Mounted
												Stalemate at less than 1.0:1													
1.0:1	.5	.9	.3	.4	.2	.4	.4	.5	.2	.3	.1	.1	.3	.4	.1	.2	.1	.1	.1	.2	.1	.1	.1	.1	NOTES:
1.5:1	.9	1.7	.5	.8	.3	.5	.8	1.0	.3	.5	.1	.3	.5	.8	.2	.4	.2	.3	.2	.4	.2	.2	.2	.2	1. Stalemate Ratio: No advance with less
2.0:1	1.3	2.0	.8	1.3	.5	.8	1.0	1.6	.5	1.0	.3	.7	.8	1.2	.4	.8	.3	.5	.4	.8	.3	.4	.3	.4	than 1:1 ratio. Assumption based on RAC
2.5:1	1.4	2.2	.9	1.4	.7	1.0	1.2	1.8	.7	1.2	.4	.8	.9	1.2	.4	.9	.3	.7	.5	.9	.4	.5	.3	.5	TBM-68.
3.0:1	1.6	2.6	1.0	1.6	.8	1.2	1.3	2.1	.8	1.3	.5	.9	1.0	1.3	.5	1.0	.4	.8	.7	1.0	.5	.7	.4	.5	2. Minefields/Barriers: Reduce rates
3.5:1	1.7	2.9	1.2	1.7	1.2	1.4	1.4	2.3	.8	1.4	.7	1.0	1.2	1.6	.7	1.2	.5	.9	.8	1.0	.5	.7	.4	.6	of advance to 75 percent when mines are
4.0:1	1.8	3.1	1.3	1.8	1.3	1.6	1.6	2.6	.9	1.6	.8	1.2	1.3	2.0	.8	1.3	.7	1.0	1.0	1.2	.6	.8	.5	.7	played.
5.0:1	2.1	3.4	1.4	2.0	1.4	1.7	1.7	2.7	1.0	1.7	.9	1.3	1.4	2.1	.8	1.4	.7	1.2	1.2	1.3	.7	.8	.6	.7	
6.0:1	2.2	3.9	1.4	2.1	1.6	1.8	1.8	3.3	1.0	1.8	.9	1.4	1.6	2.6	.8	1.6	.7	1.3	1.2	1.3	.7	.8	.7	.8	
8.0:1	2.3	4.6	1.6	2.6	1.8	2.0	2.0	3.9	1.2	2.3	1.0	1.7	1.7	3.3	.9	2.1	.8	1.6	1.3	1.4	.8	.9	.8	.9	

Table 3. Rates of advance for delaying or withdrawal actions.

Rates of Advance (kilometers per hour)

COMBAT RATIO (ATTACKER: DEFENDER)	A						B						C						D						Terrain
	GOOD		FAIR		POOR		GOOD		FAIR		POOR		GOOD		FAIR		POOR		GOOD		FAIR		POOR		Visibility
	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	Attacker Mobility D=Dismounted M=Mounted
Stalemate at less than 0.8:1																									
0.8:1	.3	.5	.2	.3	.1	.1	.3	.3	.1	.2	.1	.1	.2	.3	.1	.1	----------None----------								NOTES:
1.0:1	.6	.9	.3	.5	.2	.2	.5	.6	.2	.3	.1	.2	.3	.5	.2	.2	.1	.1	-----None----------						1. Stalemate Ratio: No advance with less than .8:1 ratio. Assumption based on RAC TBM-68, Vol III, pp 48-52.
1.5:1	1.0	1.7	.6	.9	.3	.4	.9	1.2	.3	.6	.1	.3	.6	.9	.3	.4	.1	.3	.1	.1	----None----				
2.0:1	1.5	1.9	.9	1.5	.6	.9	1.2	1.8	.6	1.2	.3	.7	.9	1.3	.4	.9	.3	.6	.4	.9	.3	.4	.1	.3	
2.5:1	1.6	2.2	1.0	1.6	.7	1.0	1.3	2.1	.7	1.3	.4	.9	1.0	1.5	.4	1.0	.3	.7	.6	1.0	.4	.6	.3	.4	
3.0:1	1.8	2.9	1.2	1.8	.9	1.2	1.5	2.4	.9	1.5	.6	1.0	1.2	1.6	.6	1.2	.4	.9	.7	1.2	.6	.7	.4	.6	2. Minefields: When minefields are employed rates of advance are reduced to 75 percent.
3.5:1	1.9	3.2	1.3	1.9	1.0	1.3	1.6	2.6	.9	1.6	.8	1.2	1.3	1.8	.7	1.3	.6	1.0	.9	1.2	.6	.7	.4	.6	
4.0:1	2.1	3.5	1.5	2.1	1.2	1.5	1.8	2.9	1.0	1.8	.9	1.3	1.5	2.2	.9	1.5	.7	1.2	1.2	1.3	.7	.9	.6	.7	3. Attack Against Withdrawing Force: Increase mounted rate by a factor of 1.5. Assumption based on RAC TBM-68.
5.0:1	2.4	3.8	1.6	2.2	1.3	1.6	1.9	3.1	1.2	1.9	1.0	1.5	1.6	2.4	.9	1.6	.7	1.3	1.3	1.5	.7	.9	.6	.7	
6.0:1	2.5	4.4	1.6	2.4	1.5	1.8	2.1	3.7	1.2	2.1	1.0	1.6	1.8	2.9	.9	1.8	.7	1.5	1.3	1.5	.7	.9	.6	.7	
8.0:1	2.5	5.1	1.8	2.9	1.6	2.1	2.4	4.4	1.3	2.6	1.2	1.9	1.8	3.7	1.0	2.4	.9	1.8	1.4	1.6	.8	1.0	.7	.8	

Table 4. Rates of advance for attacks against fortified positions.

Rates of Advance (kilometers per hour)

COMBAT RATIO (ATTACKER: DEFENDER)	A						B						C						D						Terrain
	GOOD		FAIR		POOR		GOOD		FAIR		POOR		GOOD		FAIR		POOR		GOOD		FAIR		POOR		Visibility
	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	Attacker Mobility D=Dismounted M=Mounted
												Stalemate at less than 2.0:1													
2.0:1	.2	.4	.1	.2	.1	.1	.2	.3	.1	.2	.1	.1	.1	.2	.1	.1	.1	.1	---------None-------						
2.5:1	.2	.4	.2	.2	.1	.2	.2	.3	.1	.2	.1	.1	.2	.2	.1	.2	.1	.1	.1	.1	-----None---				
3.0:1	.3	.5	.2	.3	.1	.2	.2	.4	.1	.2	.1	.2	.2	.3	.1	.2	.1	.1	.1	.2	.1	.1	.1	.1	
3.5:1	.3	.5	.2	.3	.2	.2	.2	.4	.1	.2	.1	.2	.2	.3	.1	.2	.1	.2	.1	.2	.1	.1	.1	.1	
4.0:1	.3	.6	.2	.3	.2	.3	.3	.5	.2	.3	.1	.2	.3	.4	.2	.3	.1	.2	.1	.2	.1	.1	.1	.1	
5.0:1	.4	.6	.2	.4	.2	.3	.3	.5	.2	.3	.2	.2	.3	.4	.2	.3	.1	.2	.2	.2	.1	.1	.1	.1	
6.0:1	.4	.7	.2	.4	.3	.3	.3	.6	.2	.4	.2	.3	.4	.5	.2	.3	.1	.2	.2	.2	.1	.2	.1	.1	
8.0:1	.5	.8	.3	.5	.3	.4	.4	.7	.3	.4	.3	.4	.4	.6	.3	.4	.2	.3	.2	.2	.1	.2	.1	.1	

NOTES:

1. Stalemate Ratio: No advance with less than 2:1 advantage. Assumption based on RAC TBM-68.

2. Minefields/Barriers: Table assumes use of mines/barriers.

3. Deliberate defense of a riverline is considered fortified zone.

4. For combat in cities, use basic rate above and reduce to 20 percent if deliberate defense exists.

Table 5. Rates of advance for attacks against prepared positions.

Rates of Advance (kilometers per hour)

COMBAT RATIO (ATTACKER: DEFENDER)	A						B						C						D						Terrain
	GOOD		FAIR		POOR		GOOD		FAIR		POOR		GOOD		FAIR		POOR		GOOD		FAIR		POOR		Visibility
	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	Attacker Mobility D=Dismounted M=Mounted
Stalemate at less than 1.7:1																									
1.7:1	.5	.8	.3	.4	.2	.2	.4	.6	.2	.3	.1	.2	.3	.4	.1	.2	.1	.1	.1	.2	----None-----				NOTES:
2.0:1	.6	.9	.3	.6	.2	.3	.5	.7	.2	.5	.1	.3	.3	.5	.2	.3	.1	.2	.2	.3	.1	.2	.1	.1	1. Stalemate Ratio: No advance credited at less than 1.7:1. Assumption consistent with RAC TBM-68, Vol III, pp 48-52.
2.5:1	.6	1.0	.4	.6	.3	.4	.5	.8	.3	.5	.2	.3	.4	.5	.2	.4	.1	.3	.2	.4	.2	.2	.1	.2	
3.0:1	.7	1.2	.5	.7	.3	.5	.6	.9	.3	.6	.2	.4	.5	.6	.2	.5	.2	.3	.3	.5	.2	.3	.2	.2	
3.5:1	.8	1.3	.5	.8	.4	.5	.6	1.0	.3	.6	.3	.5	.5	.7	.3	.5	.2	.4	.3	.5	.2	.3	.2	.2	
4.0:1	.8	1.4	.6	.8	.5	.6	.7	1.2	.4	.7	.3	.5	.6	.9	.3	.6	.3	.5	.5	.5	.3	.3	.2	.3	2. Minefields/Barriers: Table assumes use of minefields/ barriers.
5.0:1	.9	1.5	.6	.9	.5	.6	.8	1.2	.5	.8	.4	.6	.6	.9	.3	.6	.3	.5	.5	.6	.3	.3	.2	.2	
6.0:1	1.0	1.7	.6	1.0	.6	.7	.8	1.5	.5	.9	.4	.7	.7	1.2	.3	.7	.3	.6	.6	.6	.3	.3	.3	.3	
8.0:1	1.0	2.0	.7	1.2	.6	.8	.9	1.7	.6	1.0	.5	.8	.7	1.5	.4	.9	.3	.7	.5	.6	.3	.3	.3	.3	

Table 6. Rates of advance for attacks against hasty positions.

Rates of Advance (kilometers per hour)

COMBAT RATIO (ATTACKER: DEFENDER)	A						B						C						D						Terrain
	GOOD		FAIR		POOR		GOOD		FAIR		POOR		GOOD		FAIR		POOR		GOOD		FAIR		POOR		Visibility
	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	Attacker Mobility D=Dismounted M=Mounted
	Stalemate at less than 1.4:1																								
1.4:1	.7	1.2	.4	.6	.2	.3	.6	.8	.2	.4	.1	.2	.4	.6	.1	.3	.1	.2	.1	.2	----None-----				NOTES:
1.7:1	.8	1.3	.5	.7	.3	.4	.7	1.0	.3	.5	.2	.3	.5	.7	.2	.4	.1	.2	.2	.4	.1	.2	.1	.1	1. Stalemate Ratio: No advance is credited against hasty positions unless combat ratio favors the attacker by 1.4 or better. Assumption based on RAC TBM-68, Vol III, pp 48-52.
2.0:1	1.0	1.5	.6	1.0	.4	.6	.8	1.2	.4	.8	.2	.5	.6	.9	.3	.6	.2	.4	.3	.6	.2	.3	.1	.2	
2.5:1	1.1	1.7	.7	1.1	.5	.7	.9	1.4	.5	.9	.3	.6	.7	.9	.3	.7	.2	.5	.4	.7	.3	.4	.2	.3	
3.0:1	1.2	2.0	.8	1.2	.6	.8	1.0	1.6	.6	1.0	.4	.7	.8	1.0	.4	.8	.3	.6	.5	.8	.4	.5	.3	.4	
3.5:1	1.3	2.2	.9	1.3	.7	.9	1.1	1.8	.6	1.1	.5	.8	.9	1.2	.5	.9	.4	.7	.6	.8	.4	.5	.3	.4	
4.0:1	1.4	2.4	1.0	1.4	.8	1.0	1.2	2.0	.7	1.2	.6	.9	1.0	1.5	.6	1.0	.5	.8	.8	.9	.5	.6	.4	.5	2. Minefields/Barriers: When mines or barriers are employed, reduce rate of advance to 75 percent.
5.0:1	1.6	2.6	1.1	1.5	.9	1.1	1.3	2.1	.8	1.3	.7	1.0	1.1	1.6	.6	1.1	.5	.9	.9	1.0	.5	.6	.4	.5	
6.0:1	1.7	3.0	1.1	1.6	1.0	1.2	1.4	2.5	.8	1.4	.7	1.1	1.2	2.0	.6	1.2	.5	1.0	.9	1.0	.5	.6	.5	.5	
8.0:1	1.8	3.5	1.2	2.0	1.1	1.4	1.6	3.0	.9	1.8	.8	1.3	1.2	2.5	.7	1.6	.5	1.2	.9	1.0	.5	.6	.5	.5	

Table 7. Types of tactical situations.

Tactical Situation	Description
1. Meeting Engagement	May be assigned when one side is attacking and the other side counterattacks. Defender has advantage of natural terrain features only.
2. Delaying Action	A retrograde action where the defender exchanges space for time, seeking to delay, deceive, and disorganize attacking formations, causing them to deploy frequently.
3. Withdraw	Defender maintains covering forces in direct contact with the enemy while withdrawing the bulk of his forces to deeper positions.
4. Defend Fortified	Assumes a deliberate defense, and considered the highest degree of defensive posture attainable, requiring extensive preparation time. Includes deliberate defense of urban areas.
5. Defend Prepared	Implies installation of wire, minefields, camouflaged dug-in emplacements for crew-served weapons with minimum overhead cover. An organized defensive arrangement with overhead cover for all combat and combat support personnel concerned.
6. Defend Hasty	Use of natural cover and concealment, limited use of minefields and initiation of dug-in emplacement for crew-served weapons. Preparation time is variable.

SOURCE: SCORES "Jiffy" War Gaming Methodology, July 1975, p. 12.

Table 8. Defender tactical situation adjustment factors for maneuver unit weapons.

Defender's Posture*	Adjustment Factor
Meeting Engagement	1.0
Delaying Action	1.0
Withdraw	0.5
Defend Fortified Position	2.0
Defend Prepared Position	1.5
Defend Hasty Position	1.2

SOURCE: USMC LFWG Rules Manual, VOL XXII.

*See table 7 for definition of postures. At least 50 percent of defender's force must be in the particular posture for which a factor is selected.

Table 9. Attacker tactical situation adjustment factor for maneuver unit weapons.

Tactical Situation	Attacker Posture	Adjustment Factor
Meeting Engagement	Frontal Attack	1.0
Delay Action	Frontal Attack	1.5
Withdraw	Frontal Attack	2.0
Defend Fortified Position	Frontal Attack	0.8
	Single Envelopment*	1.0
	Double Envelopment*	1.2
Defend Prepared Position	Frontal Attack	1.0
	Single Envelopment*	1.2
	Double Envelopment*	1.4
Defend Hasty Position	Frontal Attack	1.2
	Single Envelopment*	1.4
	Double Envelopment*	1.6

SOURCE: USMC LFWG Rules Manual, VOL XXII.

*All defending units in a specific battle must be enveloped. Envelopment is only possible on a flank separated by at least 2 km from flank support.

where for all the attacking (i) and defending (k) weapon systems:

FPR = the firepower ratio.

ATSAF = the attacker tactical situation adjustment factor.

DTSAF = the defender tactical situation adjustment factor.

N = the number of the ith attacking and kth defending weapon systems.

FPS = the firepower score of the ith and kth systems.

(2) Environmental considerations. Many environmental factors may influence rates of movement. Among these are vegetation, soil composition, slope of terrain, natural barriers, weather, and various conditions that restrict visibility. Since these environmental factors cannot be measured easily and must be averaged for the conditions that exist over the entire sector, they have been reduced to only two basic factors for consideration in the Jiffy Game. The two environmental factors of interest are terrain and restriction to visibility. Descriptions of the four generic types of terrain considered in the Jiffy Game are presented in table 10. Visibility restrictions are generally considered as decrements to an observer's ability to acquire enemy weapon systems. The visibility restriction factors are given in table 11. The rate-of-advance methodology, however, considers visibility only to the extent that it is qualitatively assessed as good, fair, or poor. Good visibility corresponds to the visibility categories of 1 and 2 in table 11; fair corresponds to categories 3 and 4; poor visibility corresponds to category 5.

(3) Military considerations. Like the environmental considerations, the military factors that influence rates of advance were first reduced to those that were measurable and then were simplified to the extend possible. The intangible qualities and skills of combat, such as training, morale, fatigue, and a commander's ability to lead and maneuver his forces, are military factors that cannot be measured or quantified realistically. Of the measurable military factors, the factors considered in the Jiffy Game have been reduced to combat power (firepower ratio), mobility, and manmade barriers. Firepower ratios were discussed above. Mobility is considered only to the extent that a force is either mounted in armored vehicles or dismounted from them. Manmade barriers are considered primarily as minefields. A minefield reduces a force's rate of advance to 75 percent of what its rate of movement would be otherwise.

(4) Rate of advance. After the military and environmental considerations have been made, and the firepower ratio between the forces has been calculated as outlined, the rate of advance of the attacking force may be determined from tables 2 through 6. The rate of advance is actually a linear interpolation of the tabulated values, except for the stalemate conditions. When the firepower ratio is below the stalemate threshold shown

Table 10. Terrain types.

Type	Description
Open	a. Elevation changes from 0-50 meters per kilometer. b. Scattered light scrub growth, low bushes, low grasses, or desert. Sinai or Syrian Deserts are examples. c. Permits maximum cross-country movement and excellent fields of fire for maneuver and air defense units. d. Permits excellent surveillance and target acquisition. e. Extremely loose sand, marshes, snow cover exceeding 14 inches or boulder-strewn fields reduce trafficability to rolling type terrain.
Rolling	a. Elevation changes from 51-200 meters per kilometer. b. Farmland with small, randomly-spaced timber; primarily orchards or small woods. North German Plain between Hannover and Hamburg is an example. c. Permits near maximum cross-country movement and good fields of fire for maneuver and air defense units. d. Permits good surveillance and target acquisition. e. Snow cover exceeding 14 inches, extremely loose sand, marshes or boulder-strewn fields reduce trafficability to hilly type terrain.
Hilly	a. Elevation changes from 201-400 meters per kilometer. b. Moderate to densely forested with mixed coniferous and deciduous trees and small patches of farmland or high-grass/shrubbery. Terrain around Wildflecken, Spessart or Vogelsberg areas of Germany are examples. c. Permits limited cross-country movement and poor fields of fire for maneuver and air defense units. d. Permits poor surveillance and target acquisition. e. Jungled highlands, snow cover exceeding 14 inches, terraced fields or vineyards, or boulder-strewn slopes reduced trafficability to mountainous terrain.
Mount-ainous	a. Elevations change from 401-600 meters per kilometer. b. Thickly forested with few scattered open spaces at lower elevations. Appalachians, Korea, or the Bohemian Forest-Sudeten Mountains are examples. c. Permits very poor cross-country movement, limited chiefly to valleys and trails/roads and provides extremely poor fields of fire for maneuver and air defense units. d. Permits very poor target acquisition and surveillance. e. Snow cover exceeding 14 inches, rocky slopes restrict trafficability to existing roads and improved trails.

SOURCE: USMC Land Force Wargame Rule Manual, VOL III, 29 Jan 69, pp 6, 8, 10.

Table 11. Visibility restruction factors.

Category	Condition	Visibility Reduced to:
1	Clear day with only battle haze (visibility beyond 3,000m).	100%
2	Daylight with battle haze and dust only or light rain (visibility reduced to 2,500m).	85%
3	Daylight with moderate rain, light ground fog, smoke on windy days, light sleet or snow, night with illumination, dawn or dusk (visibility reduced to 1,700m).	65%
4	Daylight with moderate smoke, fog, snow, sleet or heavy rain; clear night, night with illumination and battle smoke and dust (visibility reduced to 1,000m).	45%
5	Daylight with heavy fog, smoke, snow; night with moderate natural illumination and light haze (visibility reduced to 500m).	30%

NOTE: Gamer adaptation of USMC Land Force War Game Rule Manual, Vol V, 29 Jan 69, pp 3, 4, and Vol VII, 23 Jun 70, pp 106.

on each specific table, the rate of advance is set equal to zero. In addition, if minefields or barriers are opposing the attacking force, the interpolated rate of advance is multiplied by .75, except for the attack of fortified or prepared defensive positions whose table values include use of minefields.

d. Effect of Attacker Massing. The Jiffy Game provides the attacking force with the capability to mass its weapons within a massing zone for FEBA penetration. This action increases the firepower ratio in the massing zone in favor of the attacker. This results in an increased rate of advance within the massing zone. The massing concept is accomplished in the Jiffy Game through the use of the following equation:

$$FPR_m = \frac{FPR - [FPR_h\ (1-f)]}{f} \qquad (5\text{-}2)$$

where:

FPR_m = the massed firepower ratio.

FPR = the firepower ratio as defined in equation 5-1.

FPR_h = the firepower ratio outside of the massing zone required to hold the enemy.

f = the fraction of the sector which is the massing zone.

In the Jiffy Game the holding firepower ratio (FPR_h) has been defined as 1.5. For example, assume the attacker enjoys an overall firepower ratio (FPR) of 3:1. The attacker wishes to mount a penetration over 25 percent of a sector (f=.25). Assuming a holding firepower ratio (FPR_h) of 1.5, the massed firepower ratio computes to be 7.5.

6. SUPPRESSION.

a. General. Suppression is the term given to the condition that occurs when the crew of a weapon system is unable to perform its duty due to fear from incoming enemy fire. Suppression is an intangible; it cannot be directly measured. Suppression occurs in varying degrees, which are related to the vulnerability of the crew. Thus, reasonable indexes of measurement for suppression appear to be crew vulnerability and volume of incoming fire.

b. Methodology. Suppression is played in the Jiffy Game as a decrement to the number of weapon systems available to fire. Suppression is based on firepower ratios as a measurement of the volume of fire and is adjusted for the vulnerability of each particular weapon system. The weapon systems of maneuver units are considered able to be suppressed by weapon systems of the maneuver and fire support elements of the opposing force. The firepower ratio

used for the suppression factor of maneuver weapon systems is the total force firepower ratio. On the other hand, the weapon systems of the fire support elements are generally considered to be beyond the direct fire range of the maneuver element weapon systems. Therefore, the firepower ratio used to determine the fire support suppression factor is the fire support firepower ratio. As defined above, the fire support firepower ratio is determined by the number of air defense artillery and missiles (if there is a significant enemy air threat), mortars, field artillery and rockets, attack helicopters, and tactical aircraft. Table 12 gives the expected percent of attacker and defender tanks suppressed for the six types of tactical situations as a function of firepower ratio. This table was developed mainly from RAC TBM-68, vol II, p. 57 as noted on the table. The values given by the table may be adjusted for weapon systems other than tanks through the use of the vulnerability adjustment factors from table 13. The value extracted from table 12 multiplied by the appropriate value in table 13 produces the expected percentage of weapon systems that are suppressed. It should be noted that there is no suppression factor for dismounted infantry. It is covered in the discussion of dismounted infantry combat assessments (paragraph 7d(4)). Another observation that can be made from table 12 is that, for a specific tactical situation, as the firepower ratio increases the percentage of suppression for the defender also increases, and the percentage of the attacker suppressed decreases. This is because as the firepower ratio increases, the attacker is able to put a greater volume of fire on the defender, which results in the percentage of the defender suppressed increasing. As the defender becomes more suppressed, fewer weapons are available to fire at the attacker. Thus, the volume of fire being received by the attacker decreases as the firepower ratio increases, and the percent of the attacker being suppressed also decreases.

7. COMBAT ASSESSMENTS.

a. General. The combat assessments of the Jiffy Game determine the attrition of weapon systems and personnel suffered by each force in combat. The assessments are made in attrition sectors, which typically are battalion size partitions of the main battle area. Since the combat assessments in a given sector are based on the number and type of individual weapons being employed in combat and their weapon characteristics, the units in the sector engaged in battle are reduced to opposing weapon system arrays. The Jiffy Game computes the number of personnel casualties and weapon system losses as a result of five different types of combat assessments. The assessments are made independently and sequentially. The order in which the combat assessments are made normally is:

- indirect fire
- minefields
- armor/antiarmor
- infantry
- attack helicopter/air defense.

Table 12. Percentages of suppression.

SITUATION	ATK OF FORTIFIED SECTOR		ATK VS PREPARED DEFENSES		ATK VS HASTY DEFENSES		MEETING ENGAGE-MENT		DELAYING ACTION		DEFENDER WITH-DRAWAL	
POSTURE	DEF	ATK	DEF	ATK	DEF	ATK	DEF	ATK	DEF	ATK	DEF	ATK
FIREPOWER RATIO (ATTACKER:DEFENDER)												
Less than 1.0:1	1.4	22.5	2.7	15.0	3.0	11.1	2.1	8.3	1.2	7.4	.8	3.7
1.0:1	1.8	14.0	3.6	9.3	3.9	6.6	3.8	3.8	1.8	4.4	1.2	2.2
1.5:1	2.4	9.9	4.8	6.6	4.8	4.5	4.5	3.2	2.7	3.0	1.8	1.5
2.0:1	3.0	8.1	6.0	5.4	6.0	3.6	4.8	3.0	3.6	2.4	2.4	1.2
2.5:1	3.5	7.2	6.9	4.8	6.9	3.0	5.6	2.5	4.2	2.0	2.8	1.0
3.0:1	3.6	6.8	7.8	4.5	7.8	2.7	6.5	2.3	5.1	1.8	3.4	.9
3.5:1	4.5	6.5	8.9	4.3	8.7	2.6	7.3	2.1	5.9	1.7	3.9	.9
4.0:1	5.0	6.3	9.9	4.2	9.6	2.4	8.1	2.0	6.6	1.6	4.4	.8
5.0:1	6.0	5.4	12.0	3.6	11.4	2.1	9.8	1.7	8.1	1.4	5.4	.7
6.0:1	6.8	5.3	13.5	3.5	12.6	2.0	11.3	1.6	9.9	1.3	6.2	.7
8.0:1	9.0	5.0	18.0	3.3	16.8	1.9	14.4	1.5	12.0	1.2	8.3	.6

SOURCES: Gamer adaptation of RAC TBM-68, VOL II, p. 57, Jan 1968 modified by factors from AMSAA Technical Memorandum 142, Proposed Criterion for Assessing the Effects of Neutralization Bombardment(U) Aug 1972 and UK Ministry of Defense Memorandum 7207, Neutralising Effects of Bombardment(U) March 1972.

Table 13. Vulnerability adjustment factors.

Weapon System	Adjustment Factor
1. Tanks	1.00
2. Other Armor	2.86
3. SP ADA and FA weapons	2.86
4. Towed ADA and FA weapons	3.52
5. Dismounted antitank weapons	2.86
6. Attack Helicopters	2.86

SOURCE: SCORES "Jiffy" War Gaming Methodology, July 1975, p. 104-105.

During the gaming of a 6-hour critical incident, the losses due to the entire 6 hours of indirect fire combat are calculated first. These losses are then subtracted from the arrays of opposing weapon systems before the next type of combat is assessed. It is obvious that with this type of combat assessment methodology, the synergistic effects of the simultaneous occurence of the different types of combat cannot be considered. In addition, it should be noted that the tactical aircraft losses and losses to tactical aircraft, although considered in the overall Jiffy War Gaming process, are determined external to the Jiffy Game (reference 6).

b. Generalized Assessment Equation. Except for minefield losses, combat attrition is determined in a nonlinear fashion. The generalized form of the assessment equation is given by equation 7-1:

$$K_k = \left[1 - \prod_{\text{all } i} \left(1 - \frac{SSKP_{ik}}{T_k}\right)^{R_{ik}}\right] T_k \qquad (7\text{-}1)$$

where, for the i on k engagements:

K_k = number of targets killed by all firers.

T_k = number of targets engaged.

R_{ik} = number of rounds fired.

$SSKP_{ik}$ = single-shot kill probability.

This equation may be considered as a one-on-one duel aggregated for all rounds shot by each type of firer and then aggregated for all types of firers. Three assumptions are inherent in the application of this equation:

(1) Each target has the probability of $1/T_k$ that it will be selected to be shot at for each round fired.

(2) The rounds are uniformly distributed against all appropriate targets.

(3) Each firing is an independent event; a target may be engaged more than once, even after damaged or killed.

c. Operational Availability. Operational availability is a parameter included in all Jiffy Game assessment calculations to account for those vehicles and other equipment not capable of entering into combat due to inoperability. Some percentage of the weapon systems in a force are, at any given time, being repaired or undergoing routine maintenance and should not be considered in the assessment process. Tables 14 and 15 give the operational availability data developed for all the weapon systems played in the Jiffy

Table 14. Operational availability of Blue weapon systems.

Blue Weapon Systems	Operational Availability
Small arms, trucks, personnel	1.00
Ground mounted antitank weapons:	
LAW, 90mm recoilless rifle	0.95
TOW	0.93
106mm recoilless rifle	0.91
Dragon	0.81
Tanks/Armored Vehicles:	
M113A1	0.90
M114A1, MICV	0.81
M60A1	0.78
XM1, M60A3	0.72
M551, M60A2	0.67
Air Defense Systems:	
Chaparral, Roland	0.88
Redeye, Stinger	0.83
Hawk, SAM-D	0.78
Vulcan	0.60
Mortars/Field Artillery;	
Towed 60mm, 81mm, 107mm/M106A1 mortars	0.94
SP 81mm/M125A1, 107mm/M106A1 mortars	0.90
Towed 105mm How, GSRS	0.86
SP 155mm/XM198 How	0.73
175mm Gun, 203mm Gun	0.67
Armed Helicopters:	
AH-1G	0.65
AH-1S	0.81
OH58	0.77
UH-1H	0.75
CH-47	0.63

SOURCES: a. For vehicles--AMSAA Technical Memorandum 102, Joint CDC/AMC M60 Tank Study, Army Materiel Systems Analysis Agency, APG, MD., February 1971. b. For artillery--US Army Field Artillery School Department of Gunnery. c. For AD systems--Army Air Defense, Europe 1970-1975, HQ USAREUR/. . Seventh Army, October 1969. d. For armed helicopters--(C) Army Aircraft Inventory Status and Flying Time(U),US Army Aviation Systems Command, St. Louis, MO., Jan-Dec 76.

Table 15. Operational availability of Red weapon systems.

Red Weapon Systems	Operational Availability
Small arms, trucks, personnel	1.00
Ground mounted antitank weapons:	
RPG 7, SPG 9	0.95
Sagger, 82mm RG	0.91
100mm T12	0.86
Tanks/Armored Vehicles:	
PT76, BMP, JSU 152, SU 100, BTR-60P, BRDM-2, ASU-85, ASU-57	0.81
T62, T72, T10M	0.78
T55, T54	0.62
Air Defense Systems:	
ZSU-23/4, ZSU-57/2, 57mm S60, 14.5mm ZPU-4, SA 6, SA 4	0.85
SA 7, SA 9	0.83
Mortars/Field Artillery:	
All Towed mortars (82mm, 120mm, 160mm), Howitzers (122mm, 152mm), Guns (130mm, 180mm)	0.86
All SP Howitzers (122mm, 152mm), Rocket Launchers (122mm MRL, 140mm MRL)	0.70
Armed Helicopters*:	
HIND	0.81
HIP	0.65
HOUND	0.75
HOOK	0.63

SOURCES: See table 14, p. 22.

*Red AH availabilities are taken to be the same as for Blue systems.

Game. The table entries represent that fraction of the weapon systems that are expected to be operationally available for combat. Throughout the Jiffy Game assessments, this operational availability is a factor applied in determining both the number of targets and the number of firers.

d. Jiffy Game Combat Assessments. A form of the generalized nonlinear assessment equation is used to evaluate all combat assessments except minefield losses. The following subparagraphs discuss the combat assessments and the associated assumptions and pertinent data.

(1) Indirect fire assessments.

(a) General. The Jiffy Game indirect fire assessment methodology determines the materiel and personnel losses resulting from the play of three phases of indirect fire support: preparation/counterpreparation fires; combat support fires, e.g., close support, counterbattery, air defense suppression, and interdiction; and final protective fires. The assessment methodology is one-sided and is repeated for all indirect fire weapon-target combinations. The methodology addresses each force, in turn, and computes the expected number of casualties a force's indirect fire assets can inflict on the opposition as determined by the number of each specific area target contained in the enemy force, the number of battery missions available for firing at each specific area target, and the combination of these parameters in the nonlinear assessment equation. The computed losses are not subtracted from the force until all assessments in a phase of combat have been made, so the order of assessing the forces does not affect the outcome.

(b) Assumptions.

1. The three phases of indirect fire combat are gamed independently and sequentially, beginning with preparation/counterpreparation fires and ending with final protective fires.

2. The attacker force can fire up to 60 minutes of preparation fires. The defender force can also fire up to 60 minutes of counterpreparation fires, but only if the attacker force fires preparation fires.

3. The defender force can fire up to 60 minutes of final protective fires; however, final protective fires lasting longer than 15 minutes are unrealistic.

4. The rate of fire for weapons firing preparation/counterpreparation missions is their sustained rate of fire.

5. The rate of fire for weapons firing combat support missions is based on their historic usage and/or resupply capability.

6. The rate of fire for weapons firing final protective fires is approximately 67 percent of their maximum rate of fire. (This assumes that only 2/3 of the units are available to fire.)

7. Blue mortars do not fire preparation/counterpreparation missions.

8. Area targets are homogeneous and generally company size.

9. All Red personnel targets are considered to be fired at with improved conventional munitions-antipersonnel (ICM-AP).

10. The Blue force has the capability to fire improved conventional munitions-dual purpose (ICM-DP). When Blue options for ICM-DP, all 155mm and 203mm howitzer missions are fired with ICM-DP instead of HE.

11. The Red force has no capability to fire ICM.

12. Crew casualties are assessed in proportion to the number of crew-served weapons lost.

13. Mounted infantry casualties are assessed in proportion to personnel carrier losses.

14. Infantry materiel losses are assessed in proportion to infantry personnel casualties.

15. A CLGP mission consists of two rounds fired at an interval of 20 seconds. One CLGP mission may be fired for each 155mm howitzer battery mission available, but every CLGP mission reduces the battery missions for conventional fire by 1/3 of a mission.

(c) Area targets. The indirect fire weapon systems fire at targets that are composed of homogeneous elements (weapon systems). The targets are typically company size, meaning the number of elements in a given target represents the expected number found in a company size area. Table 16 identifies the seventeen different types of indirect fire area targets played in the Jiffy game and defines their corresponding characteristics. The number of the kth type area targets (AT_k) in a force is determined by the following equation:

$$AT_k = Q_k N_k O_k / E_k \qquad (7\text{-}2)$$

where for the kth type weapon systems:

AT_k = the number of area targets in the force.

Q_k = the probability that the area target will be acquiried and targeted.

Table 16. Indirect fire area targets.

Map Index	Target Description	Military Worth	Elements Per Target		Operational Availability	
			Blue	Red	Blue	Red
1	Personnel (Attack)	8.36	49	31	1.00	1.00
2	Antitank team (Attack)	5.47	10	10	.93	.91
3	Tank (Attack)	12.86	10	10	.72	.70
4	Medium tank (Attack)	12.86	10	10	.72	.70
5	APC (Attack)	10.79	10	10	.74	.81
6	Trucks	2.56	3	3	.90	.90
7	AD missile radar	4.05	1	1	.83	.83
8	AD artillery	4.05	6	6	.60	.85
9	AD artillery, mounted	10.79	10	10	.60	.85
10	Mortars	6.71	6	4	.92	.86
11	Towed artillery	10.12	6	6	.86	.86
12	SP artillery	10.12	6	6	.70	.70
13	Personnel (Defend)	8.36	49	31	1.00	1.00
14	Antitank team (Defend)	5.47	2	2	.93	.91
15	Tank (Defend)	12.86	10	10	.72	.70
16	Medium Tank (Defend)	12.86	10	10	.72	.70
17	APC (Attack)	10.79	10	10	.74	.81

N_k = the number of elements in force,

O_k = the operational availability of the elements.

E_k = the number of elements in an area target.

The target acquisition probabilities (Q_k) were taken from the probability of knowledge (POK) concept developed during the Antiarmor Systems Program Review (ASPR) by representatives of the military intelligence and electronic warfare communities (reference 1). The POK were determined by a team of representatives from the US Army Intelligence Center and School (USAICS) and the US Army Security Agency (USASA) who estimated the proportional contribution of each intelligence gathering asset (expected to be available by 1985) to the total target acquisition capability as a function of generic system type, target type, range, and target location error. These individual values were aggregated with respect to proponent (MI or ASA) and constitute the probability of knowledge for the eight target types and four range bands given in table 17 for Blue intelligence assets and table 18 for Red assets. Although range is not explicitly played in the Jiffy Game, it is implied by the type of area target being targeted. For example, field artillery elements would typically be located in the 3 to 16 km range band. The weapon systems of maneuver units, on the other hand, would most likely be found in the first and second range bands. The configuration of a maneuver unit depends on its tactical situation. Correspondingly, the percent of the weapon systems in a maneuver unit that are positioned forward is also dependent upon the tactical situation. These tactical positioning percentages expressed as fractional factors are contained in table 19 for all tactical situations. The probability of knowledge for maneuver unit weapon systems have been developed by averaging the acquisition probabilities weighted by the tactical positioning factors for the first two range bands. Thus, by assuming the range band in which each generic type of weapon system would likely be positioned, the POK values can be extracted from tables 17 and 18. The POK values used in the Jiffy Game are presented in table 20. The number of elements expected to be found in a given type of target, presented in table 16, is the number of point targets in an area target expected to be fired upon with a battery mission. For example, a Red infantryman would expect to be fired upon in a group of 31 infantrymen; a Blue air defense artillery weapon is expected to be fired upon in an area target consisting of 10 vehicles (itself and 9 other vehicles). These values were qualitatively assessed by experienced military war gamers. The operational availabilities (also contained in table 16) for the elements of each type of area target were averaged from the SCORES "Jiffy" War Gaming Methodology (reference 5, pp 91-92).

(d) Fire distribution. The number of battery missions fired at each specified type of target depends on the distribution of the indirect fire battery missions available to be fired. The fire distribution is determined by an algorithm that considers a targeting scheme and the LEGAL MIX IV concept of military worth of the target. The targeting scheme is shown in table 21. It should be noted that this targeting scheme is used for the preparation/counterpreparation and combat support phases of indirect fire combat and is

Table 17. 1985 Blue assets looking at Red targets.

Probability of Knowledge

Type Unit	Range (km)			
	0-3	3-16	16-40	40+
Manuever Unit/ Command Posts	60	40	25	10
Rear Services/ Facilities	50	50	30	20
Artillery	60	60	50	20
Recon	65	40	10	--
AD Missiles	45	50	30	10
Radar Sites	50	35	15	10
ESM Sites (passive)	10	15	15	15
ESM Sites (active)	55	30	10	10

Table 18. 1985 Red assets looking at Blue targets.

Probability of Knowledge

Type Units	Range (km)			
	0-3	3-16	16-40	40+
Maneuver Units/ Command Posts	70	50	30	20
Rear Services/ Facilities	90	90	80	80
Artillery	80	60	40	20
Recon Units	50	30	--	--
AD Missiles	60	40	20	--
Radar Sites	75	50	30	20
EM Sites (passive)	--	25	15	7
EM Sites (active)	70	60	20	--

Table 19. Tactical positioning factors.

Tactical Situation	Percent Deployed Forward			
	Attacker		Defender	
	Before Contact	After Contact	Before Contact	After Contact
Meeting Engagement	.33	.67	.33	.67
Delay Action	.33	.67	1.00	.50
Withdraw	.67	1.00	.67	.33
Defense of Fortified Position	.67	1.00	.67	1.00
Defense of Prepared Position	.67	1.00	.67	1.00
Defense of Hasty Position	.67	1.00	.67	1.00

SOURCE: SCORES "Jiffy" War Gaming Methodology, July 1975, p.40.

Table 20. Probability of knowledge.

Weapon System	POK	
	Red of Blue	Blue of Red
Small arms, mortars, dismounted antitank weapons, tanks, armored vehicles, mounted AD weapons and hand-held AD missiles	.70, .50	.60, .40
AD artillery and missiles	.40	.50
Field Artillery and Rockets	.60	.60
Trucks	.80	.30

Table 21. Indirect fire targeting scheme.

Weapon Class	Type Targets Engaged
Light Mortars (60, 82mm)	Dismounted infantry, unarmored antitank weapons, mortars.
Heavy Mortars (81, 107, 120, 160mm)	Dismounted infantry, unarmored antitank weapons, mortars, ADA automatic weapons, light armor.
Light Artillery (105mm howitzer, 140 rocket launcher)	Dismounted infantry, unarmored antitank weapons, mortars, ADA automatic weapons, light armor, trucks, light artillery.
Medium Artillery (152, 155, 122, 203mm howitzers, 122 multiple rocket launcher)	Dismounted infantry, unarmored antitank weapons, mortars, ADA automatic weapons, SHORAD missiles, trucks, armor, field artillery.
Heavy Artillery (175mm howitzer, 130mm gun, 180mm gun)	ADA, Field artillery

SOURCE: SCORES "Jiffy" War Gaming Methodology, July 1975, p. 56.

not used for the final protective phase. During this phase, it is assumed that the defender will be firing all its indirect fire assets just beyond the line of contact. Thus, only the weapon systems expected to be found in the forward maneuver units are considered as appropriate targets. The military worth values for Red targets are given in table 16. Due to its massive numbers of artillery tubes, Red prefers to fire barrage type missions. Thus, the military worth associated with all Blue targets is unity. In general, indirect fire battery missions are distributed among all appropriate targets according to the expression:

$$FDF_k = \frac{AT_k \; MW_k \; FAC_k}{\sum_{\text{all } k} (AT_k \; MW_k \; FAC_k)} \qquad (7\text{-}3)$$

where for the kth type of area target:

FDF_k = the fire distribution factor.

AT_k = the number of area targets.

MW_k = the military worth of the area target.

FAC_k = a fire allocation constant.

The fire allocation constant (FAC_k) is used to filter out inappropriation targets based on the targeting scheme. Thus, the FAC_k is set to one if it is an appropriate target for the indirect fire weapon being fired; otherwise, it is set equal to zero. The fire allocation constant is also used to allow the gamers the option to play any combination of close support, counterbattery, or air defense suppression missions. As an example, if a gamer did not want to fire air defense suppression missions, but wanted to concentrate his indirect fire on close support and counterbattery, the FAC_k for air defense type area targets would be set equal to zero. An exception occurs when the infantry is mounted during an attack and dismounts for a final assault on an objective. Infantry type targets are then considered to be targetable as indirect fire missions for only 1 hour. To account for this, the fire allocation constant for this case is expressed as:

$$FAC_k = 1/HR \qquad (7\text{-}4)$$

where HR is the length of indirect fire support in hours.

(e) Available battery missions. The number of battery missions a force has to fire is directly influenced by the number of tubes a force has available to fire and their rate of fire during the battle period. The rate of fire for each tube is directly influenced by the three phases of combat. The rates of fire for each type of indirect fire weapon systems have been generated for all Red and Blue indirect fire weapon systems and are contained

in table 22 for all three phases of indirect fire combat played in the Jiffy Game. The Blue weapon capabilities (sustained and maximum rates of fire) were taken from the LEGAL MIX IV study (reference 2). The Red weapon capabilities were taken from various sources as indicated on table 22. The rate of fire for all artillery and large Red mortars during preparation/counterpreparation missions are taken to be their sustained rate of fire. Since final protective fires cannot be considered preplanned fires, not all indirect fire assets will be available to fire. Experienced military gamers have determined that it is reasonable to assume that only 67 percent of the assets would be available. Thus, the rates of fire of all indirect fire weapons during final protective fires are taken to be 67 percent of their maximum rate of fire. The combat support rates of fire for Blue artillery were also developed from the LEGAL MIX IV study. They are based on the resupply rate capability, which is considered to be 2½ turnarounds of organic vehicles per day. For Blue mortars the expected rates of fire for combat support were taken from the results of the Army Mortar Requirements Study. Since no data were available for Red systems to the level of detail required to develop expected rates of fire for combat support, the rates shown in table 22 assume that the Red system fires the same percent of its basic load as the equivalent Blue system. The rates of fire of the indirect fire weapon systems, during the combat support phase, are also affected by the intensity level of artillery support required. These levels allow the gamers to adjust the rates of fire to the appropriate intensity level for the situation being gamed. The artillery intensity levels and their corresponding multipliers are given in table 23. In addition to this, certain battery missions such as smoke, illumination, and HI missions, are not fired at specific targets. Based on an analysis of the types and number of missions played during the LEGAL MIX IV Study (reference 2), it has been discerned that the field artillery fires approximately 13 percent of their mission as smoke, illumination, and HI missions, whereas mortars fire only 3 percent. A battery mission is defined to consist of six battery volleys; i.e., every tube of a battery fires six rounds in a battery mission. The number of tubes in a battery are defined in table 24 for each type of indirect fire weapon system. The number of battery missions that will be fired by a given type of indirect fire weapon system at a specific type of area target is determined by the equation:

$$BM_{ik} = \left(\frac{N_i}{TBAT_i}\right) O_i F_i \left(\frac{ROF_i \; AIL_i}{RPM_i}\right) S_i \; FDF_{ik} \qquad (7\text{-}5)$$

where for the ith type weapons firing at the kth type area targets:

BM_{ik} = the number of battery mission available to be fired.

N_i = the number of weapons in the force.

$TBAT_i$ = the number of tubes per battery.

O_i = the operational availability of the weapon.

F_i = the fraction of targeted missions (excludes smoke, illumination, and HI fired).

Table 22. Indirect fire weapon systems rates of fire.

Weapon	Rate of Fire (Rds/Hr/Tube)				
	Capabilities		Combat Rates		
	Maximum	Sustained	Prep[a]	Cbt Spt[b]	FPF[c]
BLUE:[d]					
60mm MORTAR	568	480	0	14	379
81mm MORTAR	504	300	0	7	336
107mm MORTAR	360	180	0	9	240
M106A1	360	180	0	9	240
M125A1	504	300	0	7	336
105mm Howitzer	264	180	180	28	176
155mm SP Howitzer	96	60	60	11	64
203mm SP Howitzer	40	30	30	6	28
175mm Gun	40	30	30	8	28
155mm (XM198)	96	60	60	11	64
GSRS	240	80	80	19	128
RED:[e]					
82mm MORTAR	1200[g]	400[h]	0	54	800
120mm MORTAR	420	100	100	18	280
160mm MORTAR	180[g]	60[h]	60	7	120
122mm Howitzer	480	100	100	25	320
152mm Howitzer	360	90	90	11	240
122mm SP Howitzer	480	100	100	25	320
152mm SP Howitzer	360	90	90	11	240
130mm Gun	360	100	100	25	240
180mm Gun	60	20[h]	20	17	40
122 MRL	240	80[i]	80	12	160
140 MRL	192[f]	32[i]	32	19	128

a. Sustained rate of fire for all artillery and large Red mortars.
b. Rate of fire based on estimated resupply rates.
c. 67% of maximum rate of fire.
d. SOURCE: LEGAL MIX IV study (reference 2) and Army Mortars Requirements Study (reference 7).
e. Except as noted source of Red weapons was CACDA HB 550-2.
f. SOURCE: USAREUR PAM 30-60-1, VOL I (reference 8).
g. SOURCE: USAREUR Pam 30-60-1, VOL II (reference 9).
h. Sustained rate of fire taken to be 1/3 maximum rate of fire.
i. 2 salvos per hour includes time to displace to reload point and reposition to fire.

Table 23. Artillery intensity levels.

Level	Description	Multiplier
6	Sustained Rate of Fire (This may exceed maximum daily resupply rates if fired for prolonged durations of time)	(4)
5	Rate of Fire based upon daily resupply rate plus the basic load.	(2.5)
4	Rate of Fire based upon daily resupply rate.	(1.67)
3	Rate of Fire based upon basic load being fired in one day.	(1.0)
2	Rate of Fire for 2/3 basic load in one day.	(.67)
1	Light intermittant rate of fire.	(.35)

Table 24. Number of tubes per battery.

Blue		Red	
Weapon System	Number of Tubes/Battery		Number of Tubes/Battery
60mm Mortar	3	80mm Mortar	6
81mm Mortar	3	120mm Mortar	6
107mm Mortar	4	160mm Mortar	6
M106A1	4		
M125A1	3		
105mm Howitzer	6	122mm Howitzer	6
		152mm Howitzer	6
155mm SP Howitzer	6	122mm SP Howitzer	6
203mm SP Howitzer	4		
175mm Gun	4	130mm Gun	6
155mm Gun	6	180mm Gun	6
		122mm MRL	6
		140mm MRL	6

ROF_i = the rate of fire for the given phase of combat.

AIL_i = the artillery intensity level desired.

RPM_i = the rounds per tube per mission.

S_i = the suppression factor for the weapon.

FDF_{ik} = the fire distribution factor.

A battery mission of six rounds per tube is not intended to restrict the volume of fire placed on a specific target; it serves only as the basis to make the assessment calculations. Fractional or multiple battery missions may be fired at a specific target depending on the nature of the target and the phase of indirect fire combat.

(f) Fractional damage. Indirect fire weapon system effectiveness is based on a measurement known as fractional damage. Fractional damage is that portion of a target complex that is expected to be damaged for each indirect fire battery mission fired at the target. The fractional damage values for HE and ICM-AP rounds were generated with the AMORES Indirect Fire Model (AIFM), a computer program that simulates an artillery battery of any given type firing any number of battery volleys at specified target complexes. A more detailed discussion of AIFM and its application to develop the Jiffy Game fractional damage values may be found in part 2, annex B-II. The fractional damage values used for ICM-DP rounds were developed through application of the mathematical model discussed in part 2, annex B-III. Since Cannon Launched Guided Projectiles (CLGP) rounds are fired at point targets, and not area targets, fractional damage is not a meaningful measure of effectiveness for them. CLGP assessments are discussed in subparagraph (h) below. The Jiffy Game fractional damage values are classified and are presented in part 2, tables B-3 and B-4 in appendix B. The unclassified fractional damage values contained in table 25 were developed for documentation and demonstration purposes.

(g) Indirect fire assessment algorithm. The form of the generalized assessment formula (equation 7-1) that calculates the expected number of personnel casualties and materiel losses as a result of the indirect fire combat is:

$$IDFK_k = \left\{1 - \prod_{\text{all } i} \left[1 - \left(\frac{FD_{ik}}{AT_k}\right)\right]^{BM_{ik}}\right\} AT_k E_k \qquad (7\text{-}6)$$

where for the ith type firers shooting at the kth type area targets:

$IDFK_k$ = the number of target elements killed by all indirect fire weapons.

FD_{ik} = the expected fractional damage to the area target for each indirect fire mission it receives.

Table 25. Indirect fire fractional damage.

Target	Blue Arty/Msl (HE/ICM-AP)	Blue Artillery (ICM-DP)	Red Arty/Msl (HE)
Personnel (Attack)	.005	.2	.005
Antitank Team (Attack)	.005	.2	.005
Tank (Attack)	.005	.2	.005
Medium Tank (Attack)	.005	.2	.005
Armored Personnel Carrier (Attack)	.005	.2	.005
Truck	.005	.2	.005
Air Defense Artillery Missile Radar	.005	.2	.005
Air Defense Artillery	.005	.2	.005
Air Defense Artillery, Mounted	.005	.2	.005
Mortars	.005	.2	.005
Towed Artillery	.005	.2	.005
SP Artillery	.005	.2	.005
Personnel (Defend)	.005	.2	.005
Antitank Team (Defend)	.005	.2	.005
Tank (Defend)	.005	.2	.005
Medium Tank (Defend)	.005	.2	.005
Armored Personnel Carrier (Defend)	.005	.2	.005

NOTE: See tables B-3 and B-4 in part 2 of this report for classified fractional damage values.

AT_k = the number of area targets.

BM_{ik} = the number of battery missions fired at the area targets.

E_k = the number of elements in an area target.

Since the quantity $IDFK_k$ is the expected number of k-type kills by all indirect fire weapon systems, the portion of these kills accredited to each type of weapon system must be determined. The portion of the total kills that each type of indirect fire weapon system killed is approximated by the expression:

$$PIDFK_{ik} = \frac{1.-PK_{ik}}{\sum_{\text{all } i} (1.-PK_{ik})} IDFK_k \qquad (7\text{-}7)$$

where, for $IDFK_k$ as defined above:

$PIDFK_{ik}$ = the portion of the total kth type targets killed accredited to being killed by the ith type weapon systems.

$1.-PK_{ik}$ = the expected probability of killing a kth type target by all the ith type weapon systems and is expressed by:

$$PK_{ik} = \left[1 - \left(\frac{FD_{ik}}{AT_k}\right)\right]^{BM_{ik}} \qquad (7\text{-}8)$$

with FD_{ik}, AT_k, and BM_{ik} as defined above.

(h) CLGP. Cannon Launched Guided Projectiles (CLGP) are played in the game as Blue indirect fire weapon systems that fire at point targets. CLGP missions are fired by 155mm howitzers, towed or self-propelled. A CLGP mission is considered to consist of two 155mm tubes firing one round each, 20 seconds apart. Guidance for the CLGP rounds is assumed to be provided by a ground locater laser designator (GLLD). The number of CLGP missions available to be fired is equal to the number of 155mm battery missions available. Since a CLGP mission requires two tubes to fire, the number of available 155mm missions is reduced by 1/3 of a mission for every CLGP mission fired.

1. The CLGP missions are fired at Red armor vehicles, which include tanks, BMPs, BRDMs, BTRs, assault guns, and mounted air defense weapons. Because the CLGP missions are fired at these point targets, their fire distribution algorithm differs from that of the other indirect fire missions. The CLGP fire distribution is expressed as:

The CLGP probabilities of kill are classified and may be found in part 2, appendix B, paragraph B-3. Unclassified kill probabilities against light armor and tanks have been arbitrarily set at .5 and .4, respectively. These probabilities assume that the laser designator is not suppressed (i.e., has continuous line of sight and can designate the target). The probability that the GLLD is not suppressed is also classified and may be found in part 2, appendix B. The unclassified value has been set at .5.

(i) Other assessments due to indirect fire combat. Since the indirect fire combat assesses dismounted infantry and crew-served weapons, additional attrition of crews, mounted infantry personnel, and the materiel losses associated with infantry casualties are made in accordance with the methods presented under infantry assessments and crew losses (paragraph 7c(4)).

(j) Ammunition expenditures. A tally of each type of round fired during the indirect fire combat is kept for the ammunition expenditure statistics. Since the number of battery missions calculated for each type of weapon system is the number of targeted missions fired, the number of rounds fired for all missions are in accordance with the distribution of fire missions determined for each type of tube as shown in table 26. Smoke (HCL) and WP type rounds are fired for smoke and illumination missions, respectively. Harrassment and interdiction (HI) missions are assumed to be fired with HE. The remainder of the Blue indirect fire missions are the targeted missions expending either HE, ICM-DP, ICM-AP, or CLGP rounds. The Red force fires HE rounds for all but their smoke and illumination missions.

(2) Minefield assessments.

(a) General. The minefield assessments determine the attrition of dismounted infantry personnel and armored vehicles as a result of an attacking force passing through a mined sector using "bull" tactics or a hasty breach technique. The methodology considers both conventional and FASCAM minefields against attacker weapon systems; defenders are not assessed. The expected losses are determined linearly based on mine density and the minefield-sector geometry. The data for conventional minefields are extracted from the Army field manuals on maneuver control (FM 105-10) and landmine warfare (FM 20-32). The mine effectiveness data consider antitank (M15), antipersonnel blast (M14), and antipersonnel fragmentation (M16) type mines. The source document for the FASCAM data was a FASCAM concept paper by the US Army Engineer School (reference 9).

(b) Assumptions.

1. Weapon systems are considered to be dispersed uniformly across the trafficable terrain of the sector.

2. The Red force is using a hasty breach technique to pass through the minefield. Note: If the Red force is bypassing, clearing, or deliberately breaching the minefield, they should suffer no attrition from the minefield.

Table 26. Indirect fire mission distribution.

	TYPE OF MISSION		
	Smoke/Illumination	H & I	Other
BLUE:			
Mortars	.03	.00	.97
105mm Howitzer	.03	.10	.87
155mm Howitzer	.03	.10	.87
175mm Howitzer	.00	.13	.87
203mm Howitzer	.00	.13	.87
GSRS	.00	.13	.87
RED:			
Mortars	.00	.03	.97
122mm Howitzer	.13	.00	.87
152mm Howitzer	.00	.13	.87
130mm	.00	.13	.87
122 MRL	.00	.13	.87
140 MRL	.00	.13	.87

3. The minefields are composed of both AP and AT mines.

4. Conventional minefields are a minimum of 150m in depth.

(c) Minefield characteristics. Minefields are generally characterized by their mine density and length of frontage. Conventional minefields are considered to be a minimum of 150 meters in depth. The frontage and density are determined by the type of minefield, means of emplacement, and hours and resources available to emplace the minefield.

1. Conventional minefields are emplaced by personnel, either manually or with mechanical mine planters.

a. The amount of manhours required to manually emplace each 100 meters of frontage is a function of the mine density of each type of mine being planted. Table 27 contains the manhour requirements for the manual emplacement of conventional minefields of 100 meter fronts for various densities of antitank mines, which includes a constant density of four and eight mines per meter of front for AP FRAG and AP BLAST mines, respectively. The length of potential minefield frontage that may be emplaced manually is determined by the expression:

$$MF_{man} = \frac{N_p \cdot HR_a \cdot WDF}{MHR_{(d)}} \; 100 \qquad (7\text{-}12)$$

where:

MF_{man} = the conventional minefield frontage in meters being manually emplaced.

N_p = the number of personnel emplacing mines.

HR_a = the number of hours available to emplace the mines.

WDF = a work degradation factor.

$MHR_{(d)}$ = the man-hours required to bury 100 meters of front given in table 27 as a function of mine density.

The work degradation factor (WDF) is simply a means of degrading the efficiency of military personnel in a hostile environment. The work degradation factor is equal to .9 if the minefield is emplaced before the commencement of hostilities, and it is reduced to .7 if the minefield is being emplaced after hostilities have been initiated.

b. Mechanical mine planter platoons have a capability to emplace much greater frontages than can be emplaced manually. Mechanical mine planters emplace minefields with a mine density of two mines per meter of frontage. As depicted in table 28, Blue mechanical mine planter platoons are

Table 27. Manual minefield emplacement[d].

[a]Antitank Mine Density	Mines Required		Man Hours Required[c]
	Antitank	[b]Antipersonnel	
1	164	1836	234
2	312	1836	279
3	459	1836	323

a. Antitank mine density per 100 meter front.
b. AP mines requires combination of AP FRAG and AP BLAST.
c. Man-hours are based on laying rate of 4AT, or 8 AP FRAG, or 16 AP BLAST Mines per man-hour.
d. SOURCE: FM 20-32, Table 4-5, p. 4-5.

Table 28. Mechanical mine planter platoon capabilities.

Force	Minefield Frontage (Meters) (F)	Platoon-Hours Required (HR_r)
Blue	2000	6
Red	1000	2

SOURCE: SCORES "Jiffy" War Gaming Methodology, July 1975, p. 47.

considered able to emplace a strip of mines 150 meters in depth and 2,000 meters in width in 6 hours. Red mechanical mine planter platoons are considered able to emplace strips 150 by 1,000 meters in 2 hours. The potential frontage of a minefield emplaced by a given number of mechanical mine planter platoons is expressed by:

$$MF_{mech} = \frac{N_{mp} \cdot HR_a \cdot WDF}{HR_r} F \qquad (7\text{-}13)$$

where, for WDF as defined above:

MF_{mech} = the minefield frontage in meters being mechanically emplaced.

N_{mp} = the number of mechanical mine planter platoons emplacing the mines.

F = the amount of frontage, in meters, to be emplaced.

HR_r = the number of hours required to emplace F-meters of frontage (see table 26).

2. The densities and frontages of FASCAM minefields are determined by their means of delivery. Table 29 contains the minefield characteristics for FASCAM minefields delivered by artillery, ground emplaced mine scattering system (GEMSS), and surface launched unit mine (SLUMINE).

(d) Sector-minefield geometry. The portion of the attacking force's armored vehicles that will pass through a minefield is determined by the geometric relationships between the force, the sector frontage, and the minefield. The specific relationships of interest are the fraction of the minefield that cannot be bypassed by the attacker and the amount of trafficable terrain covered by the minefield.

1. The fraction of the minefield that cannot be bypassed is determined subjectively, external to the methodology. This judgment is based on the axis of advance of the attacker with appropriate terrain considerations. The specification of this relationship reduces the amount of minefield frontage through which an attacker must advance.

2. The amount of trafficable terrain in the sector, like the fraction not bypassed, must be qualitatively assessed with military judgment. It is simply an estimate of the amount of terrain (given in meters of width of the sector) that is trafficable to armored vehicles. If it is assumed that the armored vehicles and personnel, if dismounted, are uniformly distributed over the trafficable terrain, the probability that each vehicle or dismounted infantrymen encounters the minefield is given by:

Table 29. FASCAM minefield characteristics.

Type of Delivery	Minefield size (meters)	Mine Density* (Sq Meters)	
		Antitank	Antipersonnel
Artillery	250 x 350	.001	.0008
GEMSS	60 x 1000	.01	.003
SLUMINE	300 x 300	.0013	.0

SOURCE: US Army Engineer School Concept Paper, Family of Scatterable Mines (FASCAM), 22 Jun 1976, Appendix I, p. H-1.

*Since FASCAM minefields are not a constant 150m in width, mine density is given in square meters.

$$PCOV = \frac{F'_{by}\ (MF)}{T_t} \qquad (7\text{-}14)$$

where:

POCV = the probability an attacking weapon system encounters the minefield.

F'_{by} = the fraction of the minefield not bypassed.

MF = the minefield frontage in meters.

T_t = the amount of trafficable terrain in meters.

(e) Assessment methodology. The minefield assessments are determined in a linear fashion based on an expected percent of casualties for armored vehicles and personnel that pass through the minefield. The expected percent of casualties varies as a function of mine density for each generic type of mine. Tables 30 and 31 contain the expected percent of casualties for armored vehicles and dismounted infantry personnel passing through a conventional minefield, and tables 32 and 33 are the percent of casualties expected from FASCAM minefields. The number of armored vehicles and/or dismounted infantry personnel killed as a result of the attacking force passing through a minefield is determined by:

$$MFK_{ik} = N_k\ (PCOV)\ (FA)\ (PERCAS_{ik}/100) \qquad (7\text{-}15)$$

where for the kth type of weapon system passing through the ith type of minefield with PCOV as defined above:

MFK_{ik} = the number of weapon systems killed.

N_k = the number of weapon systems in the sector.

FA = the fraction of the attacking force that enters the minefield and is subjected to attrition.

$PERCAS_{ik}$ = the expected percent of casualties for the weapon system passing through the minefield.

Even though an attacker is using "bull" or hasty breach tactics, not all vehicles in his force will be subjected to attrition by the minefield. Instead, the attacker employs only a portion of his weapon systems to clear channels in the minefield through which the remainder of his force passes. This is accounted for in the methodology by gamer input of the FA factor in equation 7-15.

Table 30. Antitank mine tank losses expected in conventional minefields.

Antitank Mine Density Per Meter Front	Expected Percent Tank Losses
.2	10
.5	30
1	60
2	80
3	90

SOURCE: FM-105-5, table H-25, p. H-17.

Table 31. Antipersonnel mine casualties expected in conventional minefields.

AP Mine Density Per Meter Front	Expected Percent Personnel Losses
2	20
4	30
8	40
12	50
16	60
20	70
24	80

SOURCE: FM-105-5, table H-11, p. H-6.

Table 32. FASCAM AT casualties.

AT Mine Density	Expected Percent Casualties
.11	08
.2	12
.5	31
1	62
2	76
3	85
4	92
5	95

Table 33. FASCAM AP casualties.

AP Mine Density	Expected Percent Casualties
2	22
4	31
6	35
8	40
12	54
16	58
20	72
24	85

SOURCE: US Army Engineer School Concept Paper, Family of Scatterable Mines (FASCAM), 22 Jun 1976.

(3) Armor/antiarmor assessments.

(a) General. The armor/antiarmor combat assessment portrays the exchange of fire between the armored and antiarmor elements of the opposing maneuver units. Only tanks and antitank weapons are considered in the actual assessments as both firers and, except for front line air defense systems, targets. Attrition of infantry personnel and materiel, except for dismounted antiarmor weapon systems, as well as crewmen does result from the armor/antiarmor assessment but only in conjunction with losses of armored vehicles or antiarmor weapons. Losses due to indirect fire, minefields, etc. influence armored combat assessments only to the extent that the opposing force (weapon system) arrays have been reduced in strength according to the losses suffered in them. The generalized assessment equation parameterized for single shot kill probabilities and expected number of rounds fired by participating weapons is used to determine actual losses of tanks, other armored vehicles (including SP Vulcan, ZSU 23/4, and ZSU 57/2 AD systems), and dismounted antitank weapons.

(b) Assumptions. The following assumptions apply to the armor/antiarmor combat assessments:

1. Advance of the attacking force occurs in 500-meter increments.

2. The weapon systems of the attacker are uniformly distributed throughout a 500-meter-deep range band located some specified distance in front of the defender.

3. The number of rounds fired by engaging systems is directly indexed on intervisibility as determined by terrain and range.

4. The visibility conditions not only degrade the number of targets to be engaged but also determine the maximum range for engagement.

5. Distribution of fire to the target array is determined by categories of detection frequencies developed from previous DYNTACS-X applications.

6. In targeting for assessments 2/3 of the defender weapon systems are in hull defilade with 1/3 fully exposed; for the attacking force, 1/3 are in defilade while 2/3 are fully exposed.

7. Firers fire armor piercing (AP) rounds or antitank missiles, if appropriate, at heavy armored vehicles; otherwise, HEAT rounds are fired.

(c) Assessments. Given the environmental and military conditions associated with the battle being gamed, the assessment of losses incurred during armor/antiarmor combat is a relatively straightforward process. The assessment equation itself, along with the necessary preliminary computations, is given in the following subparagraphs.

1. Number of targets. The number of each type of weapon system available for targeting is determined by the equation:

$$TGT_k = NW_k \cdot OA_k \cdot VIS \cdot PSN_k \cdot ACQ \qquad (7\text{-}16)$$

where, for the kth type target:

TGT_k = the total number of weapon systems targetable.

NW_k = the number of weapon systems remaining in the force array.

OA_k = the operational availability.

VIS = a visibility degradation factor.

PSN = the tactical positioning factor of the targeted force.

ACQ = an acquisition discriminator value for the firing force.

The number of weapons remaining in the force array (NW_k) is updated as the battle progresses; that is, the losses incurred during each range increment of the conflict are subtracted from the weapon array before the subsequent assessment beings. Operational availability (OA_k) is discussed in paragraph 7c, with values for all systems played in Jiffy Game given in tables 14 and 15. Visibility degradation factors (VIS) are as presented in table 11. Tactical deployment factors (PSN), which account for the configurations of units in different types of engagements, are contained in table 19. The acquisition discriminator parameter (ACQ) used in equation 7-16 accounts for the differing capabilities to acquire targets under dissimilar tactical situations. An attacking force in particular would be expected to acquire targets at a higher rate during a meeting engagement than during an attack on a prepared defensive position. Acquisition discriminator values, given in table 34, have been adapted from USACACDA TETAM Effectiveness Evaluation and the USMC LFWG Rule Manual as noted.

2. Fire distribution. The distribution of rounds fired at the target array is weighted according to a detection frequency distribution derived from previous applications of DYNTACS-X. The weighting considers only four distinct categories of targets, as shown in table 35. Based on these weighting factors, the distribution of fire against a particular type of target is given by:

$$FDF_k = \frac{NW_k \cdot OA_k \cdot WT_k}{\sum_{\text{all } k} NW_k \cdot OA_k \cdot WT_k} \qquad (7\text{-}17)$$

Table 34. Acquisition discriminators.

Tactical Situation	Attacker	Defender
Meeting Engagement	.90	.90
Attack Against Delaying/ Withdrawing Force	.75	.90
Attack Against Hasty Defenses	.50	.90
Attack Against Prepared/ Fortified Defenses	.33	.90

SOURCE: Gamer adaption from USACACDA TETAM Effectiveness Evaluation, TM1-74, 26 Apr 74 and USMC LFWG Rule Manual, VOL XII, 14 Dec 71, p. A-1.

Table 35. Relative target acquisition frequencies.

Target Category	Attacker	Defender
Dismounted Antitank Weapons	0.6	0.6
Blue system: 90mm and 106mm recoilless rifles, TOW, LAW, Dragon		
Red system: 82mm RG, 100mm T12, RPG 7, SPG 9, Manpack Sagger		
Light Armored Vehicles	5.7	4.3
Blue system: M113A1, M114A1, SP Vulcan, ITV		
Red system: ASU-85, ASU-57, BRDM-2, BTR-60P, ZSU-57/2, ZSU-23/4		
Heavy Armored Vehicles	7.4	5.9
Blue system: MICV, MICV w/TOW, M113A1 w/TOW, M551		
Red system: JSU 152, SU 100, PT 76, BMP, BRDM-2 w/SAGGER		
Tanks	10.0	10.0
Blue system: M60A1, M60A2, M60A3, XM1 M48A5		
Red system: T62, T72, T10M, T55, T54		

SOURCE: Developed from detection/acquisition frequency distributions obtained from the Dynamic Tactical Simulation Model (DYNTACS-X).

where, for target type k with NW_k and OA_k as defined above:

FDF_k = the fire distribution factor.

WT_k = the categorized target weighting factor.

The fire distribution factor thus computed determines the number of rounds fired by each type firer at each type target as follows:

$$RND_{ik} = NW_i \cdot OA_i \cdot PSN_i \cdot ECF_i \cdot SF_i \cdot FDF_k \qquad (7\text{-}18)$$

where, for the ith type firers against type k targets and for NW_i, OA_i, PSN_i and FDF_k as defined above:

RND_{ik} = the total rounds fired.

ECF_i = the expected number of completed firings (per weapon).

SF_i = the suppression factor.

The suppression parameter, (SF_i) is discussed in paragraph 6 of this volume. The expected number of completed firings (ECF_i) represents the number of rounds a weapon can expect to fire successfully during an exposure of an enemy target. The data given in tables 36 through 39, which have been extracted from the SCORES "Jiffy" War Gaming Methodology (reference 5), are a function only of terrain type and range, not of the type target exposed.

3. Assessment equation. The total losses for a given type target are computed by the generalized assessment equation formulation as follows:

$$LOSS_k = \left[1. - \left(1. - \prod_{\text{all } i} \left(1. - \frac{SSKP_{ik}}{TGT_k}\right)^{RND_{ik}}\right)\right] \cdot TGT_k \qquad (7\text{-}19)$$

where, for all firers against kth type targets with TGT_k and RND_{ik} as defined above:

$LOSS_k$ = the total losses.

$SSKP_{ik}$ = the single shot kill probability

The single shot kill probabilities for armor/antiarmor are classified and are contained in tables B-5 and B-6 of part 2, the classified data appendixes. For unclassified processing an arbitrary value of .5 has been assigned to the SSKPs for all weapon systems. The SSKP data in the Jiffy Game are indexed by range, type firer, type target, and target posture. Since the assumption has

Table 36. Expected number of completed firings for open terrain.

Range	0-.5km	.5-1km	1-1.5km	1.5-2km	2-2.5km	2.5-3km
a. Blue Systems:						
Tanks:						
M48A5, M50A1, M60A3	.68	1.30	1.30	.92	.48	.16
M60A2, M551 ARAAV	.35	.64	.64	.48	.24	.06
AT Weapons:						
TOW ATGM	.34	.65	.65	.46	.24	.08
Dragon ATGM	.31	.37	.0	.0	.0	.0
106mm RR	.41	.55	.05	.01	.01	.0
90mm RR, LAW	.41	.0	.0	.0	.0	.0
b. Red Systems:						
Tanks:						
T54, T55, T62	.53	.71	.71	.58	.30	.10
T10M	.34	.65	.65	.46	.24	.08
PT76	.51	.98	.98	.0	.0	.0
AT Weapons:						
SAGGER ATGM	.35	.64	.64	.48	.24	.06
100mm T12	.68	1.30	1.30	.92	.0	.0
73mm Gun (BMP), SPG-9	.51	.98	.98	.0	.0	.0
RPG-7 ATRL	.51	.0	.0	.0	.0	.0
Assault Guns:						
JSU 152, JSU 122A	.34	.65	.65	.46	.24	.08
ASU 85, ASU 57, SU 100	.68	1.30	1.30	.92	.0	.0

NOTES: a. SOURCE: Gamer adaption of TETAN Effectiveness Evaluation, Part I, VOL III, pp 12-89 through 12-92. Expected number of firings based on average exposures x expected firings per exposure of sufficient duration for a shot to be fired. Data for systems other than those in TETAM is based on comparative rates of fire for like systems found in TETAM. b. Data assumes average attacker velocity as 15 mph. Data is applied to both attacker and defender. Acquisition discriminators from table 34 modify the data contained herein. c. For attacks through mined areas, against defended riverlines or against fortified obstacles, the above should be multiplied by a factor of 2.7 (average increase for reduced attacker velocity from TETAM). d. Each of the above entries assumes that initial detection occurs in the next higher range band. e. Terrain types are as described in table 10.

Table 37. Expected number of completed firings for rolling terrain.

Range	0-.5km	.5-1km	1-1.5km	1.5-2km	2-2.5km	2.5-3km
a. Blue Systems:						
Tanks:						
M48A5, M50A1, M60A3	.34	.78	.48	.46	.24	.08
M60A2, M551 ARAAV	.18	.39	.26	.24	.12	.03
AT Weapons:						
TOW ATGM	.17	.39	.24	.23	.12	.04
Dragon ATGM	.16	.24	.0	.0	.0	.0
106mm RR	.21	.40	.24	.22	.07	.0
90mm RR, LAW	.21	.0	.0	.0	.0	.0
b. Red Systems:						
Tanks:						
154, T55, T62	.27	.49	.30	.29	.15	.05
T10M	.17	.39	.24	.23	.12	.04
PT76	.26	.59	.36	.0	.0	.0
AT Weapons:						
SAGGER ATGM	.18	.39	.26	.24	.12	.03
100mm T12	.34	.78	.48	.46	.0	.0
73mm Gun (BMP), SPG-9	.26	.59	.36	.0	.0	.0
RPG-7 ATRL	.26	.0	.0	.0	.0	.0
Assault Guns:						
JSU 152, JSU 122A	.17	.39	.24	.23	.12	.04
ASU 85, ASU 57, SU 100	.34	.78	.48	.46	.0	.0

NOTE: For Source and notes see table 36.

Table 38. Expected number of completed firings for hilly terrain.

Range	0-.5km	.5-1km	1-1.5km	1.5-2km	2-2.5km	2.5-3km
a. Blue Systems:						
Tanks:						
M48A5, M60A1, M60A3	.52	1.58	1.94	1.16	.60	.30
M60A2, M551 ARAAV	.27	.85	1.03	.61	.31	.15
AT Weapons:						
TOW ATGM	.26	.79	.97	.58	.30	.15
Dragon ATGM	.25	.23	.0	.0	.0	.0
106mm RR	.34	.93	1.07	.58	.13	.0
90mm RR, LAW	.34	.0	.0	.0	.0	.0
b. Red Systems:						
Tanks						
T54, T55, T62	.33	.99	1.21	.83	.38	.19
T10M	.26	.79	.97	.58	.30	.15
PT76	.39	1.19	1.46	.0	.0	.0
AT Weapons:						
SAGGER ATGM	.27	.85	1.03	.61	.31	.15
100mm T12	.52	1.58	1.94	1.16	.0	.0
73mm Gun (BMP), SPG-9	.39	1.14	1.46	.0	.0	.0
RPG-7 ATRL	.39	.0	.0	.0	.0	.0
Assault Guns:						
JSU 152, JSU 122A	.26	.79	.97	.58	.30	.15
ASU 85, ASU 57, SU 100	.52	1.58	1.94	1.16	.0	.0

NOTE: For Source and notes see table 36.

Table 39. Expected number of completed firings for mountaineous terrain.

Range	0-.5km	.5-1km	1-1.5km	1.5-2km	2-2.5km	2.5-3km
a. Blue Systems:						
Tanks:						
M48A5, M60A1, M60A3	.42	1.48	1.52	1.08	.90	.48
M60A2, M551 ARAAV	.23	.78	.82	.56	.47	.24
AT Weapons:						
TOW ATGM	.21	.74	.76	.54	.45	.24
Dragon ATGM	.20	.25	.0	.0	.0	.0
106mm RR	.28	.87	.87	.52	.14	.0
90mm RR, LAW	.28	.0	.0	.0	.0	.0
b. Red Systems:						
Tanks:						
T54, T55, T62	.26	.93	.95	.68	.50	.30
T10M	.21	.74	.76	.54	.45	.24
PT76	.32	1.11	1.14	.0	.0	.0
AT Weapons:						
SAGGER ATGM	.23	.78	.82	.56	.47	.24
100mm T12	.42	1.48	1.52	1.08	.0	.0
73mm Gun (BMP), SPG-9	.32	1.11	1.14	.0	.0	.0
RPG-7 ATRL	.32	.0	.0	.0	.0	.0
Assault Guns:						
JSU 152, JSU 122A	.21	.74	.76	.54	.45	.24
ASU 85, ASU 57, SU 100	.42	1.48	1.52	1.08	.0	.0

NOTE: For Source and notes see table 36.

been made that not all targeted weapons are in the same posture, the SSKP value entered into the equation is a weighted average of two table values rather than a directly extracted value. For the defender force, a 2:1 ratio is assumed between weapons in defilade to those exposed. Thus, the SSKP entered for assessment against a defender's weapon system would be 2/3 of the SSKP against the weapon in defilade plus 1/3 of the SSKP against the weapon fully exposed. For an attacker weapon system, the defilade:exposed ratio is 1:2 so the SSKP used would be 1/3 of the defilade SSKP plus 2/3 of the exposed SSKP. The assessment equation as shown computes the number of a given type of target killed by all firers in the opposing force. To provide a record of the losses attributed to each firer, this total must be apportioned back to each of the different weapons that fired. The algorithm for accomplishing this apportionment is given in equation 7-20:

$$KILL_{ik} = \frac{1 - PK_{ik}}{\sum_{\text{all } i} (1-PK_{ik})} \cdot LOSS_k \qquad (7\text{-}20)$$

where, for firer i and target type k:

$KILL_{ik}$ = the number of targets killed by firer.

$LOSS_k$ = the total number of targets killed.

$1-PK_{ik}$ = the probability the firer killed the target where:

$$PK_{ik} = \left(1 - \frac{SSKP_{ik}}{TGT_k}\right)^{RND_{ik}} \qquad (7\text{-}21)$$

with all variables as defined above.

(d) Infantry/crew losses. Infantry personnel, even when dismounted, are not targeted for direct assessment. Dismounted infantrymen are attrited in direct proportion to the infantry-served antitank weapon losses, which are directly assessed. Table 40 shows the number of expected infantry personnel casualties per each of the antitank weapons considered in the Jiffy Game. The methodology for assessing mounted infantry personnel, all infantry weapons, and crew personnel is consistent with the other Jiffy Game assessments and is discussed in detail at paragraph 7d(4)(c) of this volume.

(e) Ammunition expenditures. Three types of ordnance are expended in armor/antiarmor combat assessments. Armor piercing (AP) rounds or antitank missiles are fired against heavy armored vehicles; HEAT rounds are fired against all other targets. As the assessments are made, an accounting is kept of the number of rounds fired so that ammunition consumption can be output with the assessment results.

Table 40. Infantry personnel casualties associated with antitank weapon losses.

	Infantry Losses
Blue AT Weapons:	
LAW	1
Dragon, 90mm RR	2
TOW, 106mm RR	3
Red AT Weapons:	
RPG 7	1
SPG 9, 82mm RG	2
Sagger, 100mm T12	3

SOURCE: SCORES "Jiffy" War Gaming Methodology, July 1975.

(4) Infantry assessments.

(a) General. Infantry casualties are assessed in each type of combat assessment in the Jiffy Game. The infantry combat assessment generates those losses resulting from direct conflict between the opposing dismounted infantry forces. In assessments for the other types of conflict, mounted and/or dismounted infantry personnel may be attrited. This section addresses all the various types of personnel casulaties considered in the game. Dismounted infantry combat attrition is first considered, followed by a description of the assessment procedures applied to infantry personnel/ materiel and crew personnel throughout the game.

(b) Infantry combat. The infantry combat assessment determines casualties to dismounted personnel suffered in a direct conflict between two opposing infantry forces. Attrition due to indirect fire, armed helicopter, minefields, tanks, and other major weapon systems is determined in accordance with assessments of other types of combat and is not addressed in this section of the game. As in all infantry assessments, materiel losses are computed in conjunction with infantry casualties. Both conventional and ambush tactics can be played, and any portion of the total infantry forces in a given sector can be committed to the battle.

1. Assumptions. The following assumptions apply to the infantry combat methodology:

a. During conventional infantry combat, the attacking and defending forces are as defined in the other combat assessments; however, during an ambush, the ambusher is always considered to be the attacker regardless of prior designations or other factors.

b. An infantry battle can last no longer than 6 hours.

c. Ambush tactics are valid only during the first hour; any combat beyond that must be conventional type.

d. Casualty rates are determined by the attacker-to-defender firepower ratios.

e. Infantry-served antitank weapons are attrited only when tanks are supporting the infantry combat.

f. No armored vehicles are assessed as losses by infantry combat.

g. All infantry personnel attached to units in the sector being gamed are subject to the attrition in the infantry combat assessments.

2. Firepower ratio. The firepower ratio between the attacking and defending forces provides an index to the casualty rate needed to assess infantry personnel casualties. The firepower scores of all infantry weapon systems and infantry support vehicles are cumulated to obtain the total firepower score for each force. The firepower scores for tanks are included only if the gaming tactics call for tanks to support the infantry in combat. Each total firepower score is then adjusted for the tactical situation by the appropriate coefficient from table 8 or table 9 and the ratio formed as in equation 5-1, restated here for reader convenience.

$$FPR = \frac{\sum_{\text{all } i} ATSAF_i \, N_i \, FPS_i}{\sum_{\text{all } k} DTSAF_k \, N_k \, FPS_k} \qquad (5\text{-}1)$$

The attacking and the defending forces in a conventional infantry conflict are as specified for the rate of advance calculation prior to beginning any assessments. For ambush tactics, however, the ambushing force is always the attacker regardless of this prior designation. Thus, the numerator and denominator would be reversed in the above ratio when the defending force was ambushing the attacking force. Furthermore, to account for the surprise factor expected in an ambush attack, the numerator of the ratio (i.e., the ambushing force's adjusted firepower score) is multiplied by 4.5 (reference 5, p. 43) to weight the firepower ratio in favor of the ambushing force.

3. Casualty rates. The firepower ratio as computed above indexes the casualty rates entered into the assessment equation. The casualty rates used in Jiffy Game represent the fraction of unit strength lost per hour of combat. The casualty rates for conventional combat appear in table 41, which is adapted from the USMC LFWG Rule Manual as noted. Both the computed firepower ratio and the tactical situation must be known to enter this table and find the correct casualty rates for the attacker and the defender. The values shown are used directly for an infantry force of less than battalion strength. However, if a force entering the combat is battalion size or larger, the table value is halved before being entered into the assessment equation. This accounts for the many infantrymen who would be held in reserve or located some distance from the front-line conflict during a larger scale battle and would be less susceptible to attrition by opposing infantry fire. A force committed to combat that contains 72 or more infantry personnel is assumed to be at least battalion size in the Jiffy Game. It should be emphasized that not all the infantry personnel need be committed to combat, and the casualty rate reduction is based on the size of the force actually committed. For example, even though a full battalion is located in a sector, the table value for the casualty rate would not be halved if only one or two companies from that battalion entered the conflict. The casualty rates for an ambush situation are contained in table 42, also adapted from the USMC LFWG Rule Manual. Only the firepower ratio is needed to extract the appropriate casualty rates from this table. These values are used exactly as shown

Table 41. Ground combat personnel casualty rate*
(Company or separate platoon per hour)

Tactical Situation	Combat Force Ratio													
	.5 & Under		.6-1.0		1.1-1.5		1.6-2.0		2.1-2.5		2.6-3.0		3.1 & Over	
	Atk	Def	Atk	Def	Atk	Def	Atk	Def	Atk	Def	Atk	Def	Atk	Def
Fortified or Prepared Position	.037	.015	.026	.019	.020	.021	.018	.025	.016	.027	.015	.031	.014	.034
Hasty Position	.027	.019	.017	.018	.013	.022	.012	.024	.010	.029	.009	.033	.008	.035
Meeting Engagement	.025	.018	.015	.016	.012	.020	.010	.021	.009	.025	.008	.029	.007	.032
Delay or Withdraw	.025	.007	.015	.009	.012	.011	.010	.014	.009	.016	.008	.019	.007	.021

* Multiply casualty rate by .5, if force is battalion or larger in size.

SOURCE: Adaptation of USMC LFWG Rule Manual VOL VIII, p. A-30.

Table 42. Ambush personnel casualties.

Maneuver Firepower Ratio	Percent Casualties	
	Ambushed Unit	Ambushing Unit
.1 - .9:1	10	20
1.0 - 1.9:1	20	15
2.0 - 2.5:1	35	10
2.5 - 3.0:1	50	5
3.1:1 or greater	70	2

SOURCE: Adaptation of USMC LFWG Rule Manual, VOL III, p. A-33.

regardless of the size of the forces since in an ambush, the assumption is made that all infantry personnel committed would be directly involved in the conflict.

4. Assessment equation. Assessment of infantry losses is made by the equation:

$$LOSS = (PERS \cdot F) \cdot [1 - (1 - Rate)^{H_R}] \qquad (7\text{-}22)$$

where, for each force:

LOSS = the number of infantry personnel casualties.

PERS = the total infantry personnel in the force array.

F = the fraction of infantry personnel committed to combat.

RATE = the personnel casualty rate.

HR = the length of battle.

This equation is applied separately to each of the opposing forces. The fraction, F, of personnel committed to battle, a value between 0 and 1, together with the total infantry personnel, PERS, in the force array determine the number of personnel available for attrition. This factor is applied to both forces and allows for gaming situations in which only a portion of each infantry force in a sector are expected to enter the conflict. The length of a battle, HR, can be no more than 6 hours; the actual number of hours entered is prescribed by the situation being gamed. When ambush tactics are played, only the first hour of combat is assessed at the ambush casualty rate because the element of surprise would not reasonably be expected to last any longer. The conflict then reverts to conventional infantry combat for the remainder of the assessment period. The casualty rate, RATE, is extracted from the tables as described in the preceding paragraph. There is no factor for suppression in equation 7-22; suppression was considered in the development of the casualty rates and thus is inherent in the RATE values.

5. Materiel losses. The infantry combat assessment equation determines only infantry personnel casualties. Materiel losses are generated as a function of the personnel loss in accordance with the methodology described below.

(c) Infantry losses. Losses of infantry personnel, associated weapons and other materiel, and crew personnel are determined in each of the combat assessments of the Jiffy Game. In most instances, the actual losses incurred are not the result of a direct assessment but rather are a function of other weapon system losses. The methodology and data for determining these losses are consistent throughout the Jiffy Game and are presented in the following subparagraphs.

1. Assumptions. Some basic assumptions underlying all infantry and crew loss calculations are:

a. Defending infantry personnel are always dismounted from their vehicles.

b. Attacking personnel can be either mounted or dismounted depending on the game situation.

c. Mounted infantry personnel are only killed when an armored personnel carrier is killed.

d. Infantry weapons are lost only as a result of infantry personnel kills.

e. When a crew-served weapon or vehicle is killed, crewmen associated with it are also killed.

2. Infantry personnel. The attrition of infantry personnel is determined by different methods for mounted and for dismounted personnel. In the case of dismounted personnel, the losses are computed directly from the assessment equation; that is, dismounted infantry are simply potential targets for which probabilities of kill have been developed and against which fire is allocated. Mounted infantry, on the other hand, suffer casualties what would be expected in proporation to losses of personnel-carrying vehicles at a rate of six infantrymen per vehicle; that is, the number of personnel carriers killed by a direct assessment multiplied by six produces the expected number of mounted infantry personnel attrited.

3. Materiel losses. When a force loses infantry personnel, it also loses trucks, rifles, light and heavy machineguns, squad antitank weapons, grenade launchers, and other infantry weapons. None of the Jiffy Game routines directly assess losses for these weapons and materiel. Rather, each type of infantry materiel in the weapon system array is assessed in proportion to infantry personnel losses. The loss rates, representing the number of systems lost per infantryman, were taken from the SCORES "Jiffy" War Gaming Methodology (reference 5) as given in table 43. The losses of infantry materiel are computed as the product of the number of personnel killed and the appropriate loss rate. No distinction is made between mounted and dismounted infantry in assessing materiel attrition except for trucks, which are only killed in conjunction with dismounted personnel losses.

4. Crew losses. The loss of a crew-served weapon system in any assessment of the Jiffy Game results in the loss of a portion of its crew as well. The total crew personnel attrited is the product of the number of weapon systems killed and the number of crewmen losses associated with that system. Tables 44 and 45 give the number of crewmen losses associated with each type of Blue and Red crew-served weapon system, respectively.

Table 43. Infantry materiel casualty distribution.

Nomenclature	Loss Rate
Trucks	.017
Personnel	1.000
Rifles	.200
Grenade Launcher	.067
Lt MG	.050
Hv MG	.020
Lt AT WP	.050
Med AT WP	.020
Recoilless Rifle (Lt)	.050
Recoilless Rifle (Hv)	.020

SOURCE: SCORES "Jiffy" War Gaming Methodology, July 1975, p.103.

Table 44. Crew losses per Blue weapon systems lost.

	Crew Losses
Weapon System:	
Ground TOW	2
Tanks:	
M60A1, M60A2, M60A3, XM1, M551, M48A5	3
Armored combat vehicles/personnel carriers:	
M113A1, M113A1/TOW, M114A1, MICV,	2
ITV	3
Air Defense Systems:	
Vulcan	4
Redeye, Stinger	2
Chaparral, Roland	5
Mortar and Field Artillery Systems:	
60mm Mortar	4
81mm Mortar, M106A1, M125A1	5
107mm Mortar	7
155mm Howitzer	10
203mm Howitzer	13
175mm Gun	14
Helicopters:	
AH1G, AH1S, OH58	2
UH1H, CH-47	4

SOURCE: SCORES "Jiffy" War Gaming Methodology, July 1975.

Table 45. Crew losses per Red weapon system lost.

Weapon System	Crew Losses
Manpack Sagger	2
Tanks:	
T62, T72, T55, T54, T10M, PT76	3
Armored Combat Vehicles/Personnel Carriers:	
BMP, BTR-60P, BRDM-2, BRDM-2/SAGGER	2
ZSU 152, SU 100, ASU-85, ASU-57	3
Air Defense Systems:	
SA-7	1
SA-9	2
ZSU-23/4, ZSU-57/2	4
57mm S60	7
14.5mm ZPU-4	
Mortar and Field Artillery Systems:	
82mm Mortar, 120mm mortar, 140mm MRL	5
122mm MRL	6
160mm Mortar, 122mm Howitzer	7
122mm SP Howitzer	8
130mm Gun	9
152mm Howitzer, 180mm Gun	10
Helicopters:	
HIND-A, HIP	2
Hound, Hook	4

SOURCE: See table 41.

(5) Attack helicopter/air defense assessments.

(a) General. Attack helicopter and air defense assessments are considered simultaneously in the Jiffy Game in order to portray the interactions between these two types of systems realistically. The definition of attack helicopter cells is the key to the assessment methodology. The configuration of the helicopter cells and the environmental factors affecting air defense capabilities are played in accordance with the combat situation being gamed and are the primary parameters in determining the casualties suffered by helicopters and ground forces alike. A formulation of the general assessment equation, equation 7-1, is used to compute losses of major weapon systems (including helicopters) and dismounted infantry personnel. Attrition of mounted infantry personnel, all infantry weapons/materiel, and crew personnel is determined by the methods detailed in paragraph 7d(4)(c) above.

(b) Assumptions. The attack helicopter and air defense assessment methodologies are subject to the following assumptions:

1. Helicopters fire only at front line weapon systems (e.g., tanks, APCs) and dismounted infantry. They fire at no artillery units and only front line air defense systems.

2. Helicopter missions are essentially attack missions. Troop-carrying helicopters and the associated missions are not portrayed in the existing logic or data.

3. Allocation of helicopter fire is based on firepower scores.

4. Air defense systems cannot distinguish among the different types of helicopter for fire allocation against heterogeneous attack cells.

5. The air defense assets in a sector are taken to be equally distributed among the major axes of advance within the sector.

6. Attack helicopters are subject to attrition by only SHORAD systems unless the AH penetrate the FEBA.

7. A sortie consists of one takeoff and landing of an aircraft; a mission is the completion of a sortie by one or more helicopters.

(c) Helicopter attack cells. The helicopter and air defense assessments are keyed on the definition of an attack cell of helicopters. An attack cell is simply a group of helicopters specified by the gamer. When a cell has been defined, the characteristics of the helicopters it contains basically determines the mission profile for the cell and the assessments are made. The game allows for more than one attack cell mission to be flown. The attack cell may contain any mixture of helicopters loaded into a force weapon system array. The maximum number of each type in a particular cell is limited

by the smaller of two numbers: 1) the actual number of remaining helicopters, or 2) the number of sorties remaining for that type. Also, these numbers ultimately constrain the number of missions that can be flown, since helicopters are killed (except in the unlikely event that there are no opposing air defense weapons) and sorties are used up for each mission. The number of a particular type helicopter, k, which is available to be entered in a given cell, n, is computed by:

$$N_{kn} = AC_k * OA_k - \sum_{i=1}^{n-1} LOSS_{ki} \qquad (7\text{-}23)$$

where, for type k helicopters flying the nth mission:

N_{kn} = the number of helicopters available for the mission.

AC_k = the total number of helicopters in initial weapon array.

OA_k = the aircraft operational availability.

$\sum_{i=1}^{n-1} LOSS_{ki}$ = the number of helicopters lost to air defense systems during previous missions.

Operational availability values are contained in tables 14 and 15 for all helicopters portrayed in the Jiffy Game. The number of helicopter sorties available for the nth mission is found by:

$$SORT_{kn} = AC_k * OA_k * SPH_k * H - \sum_{i=1}^{n-1} N_{ki} \qquad (7\text{-}24)$$

where, for the type k helicopters to fly the nth mission with AC_k and OA_k as defined above:

$SORT_{kn}$ = the number of sorties available.

SPH_k = the number of sorties per hour flown by the helicopter ($0 < SPH_k \leq 3$).

H = the number of flying hours available during the sector being gamed (maximum = length of the critical incident as set in rate-of-advance).

$\sum_{i=1}^{n-1} N_{ki}$ = the number of helicopters flown in previous missions.

The sorties per hour (SPH_k) and time (H) factors in this equation are defined by the helicopter capabilities and the battle situation as determined by the game being played.

(d) Mission profile. An attack helicopter mission in the Jiffy Game consists of an attack cell expending or attempting to expend its entire ordnance load against opposing ground forces. This is portrayed not as a single attack but as a series of helicopter pop-ups. The number of pop-ups needed to complete a mission is a function of the ordnance loads of helicopters in the cell. Each distinct type of helicopter represented in the game has associated with it a fixed ordnance configuration as given in table 46. Further, the number of rounds that can be successfully fired during a single pop-up is given in table 47 for each of the four types of ordnance. These two tables are used to calculate the number of pop-ups a given type helicopter requires to complete a mission (expend its entire ordnance load) as follows:

$$NPOP_k = \sum_{i=1}^{4} \frac{ORD_{ki}}{SROF_i} \qquad (7\text{-}25)$$

where, for the type k helicopters expending the ith type round:

$NPOP_k$ = the number of pop-ups until the helicopter depletes its ordnance.

ORD_{ki} = the number of rounds in the ordnance load.

$SROF_i$ = the success rate of fire (per pop-ups) for the round.

Inspection of equation 7-25 reveals that $NPOP_k$ is the summation of the number of pop-ups required to completely expend each type of ordnance, as if they were being fired sequentially. For a cell containing two or more types of helicopters, the number of pop-ups needed to complete the mission is equal to: max ($NPOP_1$, $NPOP_2$....$NPOP_n$) where $NPOP_k$ is the result of equation 7-25 for type k helicopters. Consequently, some types of helicopters in a heterogeneous cell may expend all their ammunition before the mission for the entire cell is complete. In any case, all helicopters remaining in the cell are assumed to be flying and can be engaged by air defense weapons even though they can no longer fire back. A cell containing only observation and/or transportation helicopters, which carry no ordnance (i.e., NPOP=0), flies a mission consisting of a single pop-up for assessment purposes. To complete the mission profile for an attack cell that has been defined, a determination must be made as to whether or not the mission being flown requires penetration of the FEBA. If the FEBA is crossed, all air defense systems of the opposing force are allowed to engage the helicopters, whereas only short range air defense systems engage a cell that does not penetrate the FEBA. This aspect of the mission profile in no way directly influences either the capabilities or the effectiveness of helicopters against ground systems.

(e) Assessments. The basic assessment equation used for both attack helicopter and air defense assessments is discussed in paragraph 7b. Detailed here are the sequencing of the assessments along with the parameters and data used to apply the general equation to these assessments.

Table 46. Armed helicopters ordnance loads.

	Type Ordnance	Rounds Carried
Blue Helicopters:		
AH-1G - Type 1	2.75 Rocket 20mm Cannon	14 4[a]
Type 2	2.75 Rocket	52
AH-1S	Aerial TOW	8
OH58, UH1H, CH-47	None	None
Red Helicopters:		
HIND A - Type 1	Swatter[b] 57mm Rocket Aerial	4 128 1[a]
HIP	57mm Rocket Aerial HMG	128 1[a]
HOOK, HOUND	None	None

SOURCE: Ordnance loads represent configurations most desireable for "Jiffy" war gaming as determined by the military gaming staff.

a. Bursts consisting of 125 rounds.
b. Weapon characteristics taken to be those of the SAGGER.

Table 47. Number of rounds fired per helicopter pop-up.

Type Ordnance	Rounds Successfully Fired	
	Blue	Red
AT Missile (TOW, Swatter[b])	.8	.8
Rockets	10.0	25.0
HMG[a]	2.0	2.0
Cannon[a]	.8	.8

SOURCE: Developed by experienced Army Aviators for use in the Jiffy Game.
a. Burst consisting of 125 rounds.
b. Weapon characteristics taken to be those of the aerial Sagger.

1. Per pop-up assessments. As outlined above, a mission consists of a series of pop-ups by an attack helicopter cell. Each pop-up represents an opportunity both for the helicopters to fire and for air defense to engage the helicopters. Therefore, losses are assessed for each pop-up individually. At the end of a given pop-up, all weapon system arrays are updated before assessments for the next pop-up are begun. If, at any time during the iterations of the assessments, the number of helicopters remaining in a cell falls below 70 percent of the initial number within that cell, the mission may be aborted at the gamer's option, and no further assessments for that cell are made. If not aborted, a mission will be processed, pop-up by pop-up, to its completion.

2. Air defense assessments. The effectiveness of air defense weapons against helicopters is dependent on several factors determined by the environmental and battlefield characteristics. These parameters affect the assessment equation either by modifying the number of engagements against the helicopters or by indexing different values in the kill probability data array.

a. Air defense systems available. The number of air defense weapons available to engage helicopters for an assessment is found by:

$$EWPN_i = (NW_i * OA_i - LOSS_i) * TMASK/NCORR \qquad (7\text{-}26)$$

where, for the type i AD weapon system:

$EWPN_i$ = the expected number of AD weapons available.

NW_i = the number of AD weapons initially in force array.

OA_i = the operational availability of the AD systems.

$LOSS_i$ = the number of AD systems killed by helicopters in prior assessments.

TMASK = a terrain masking factor.

NCORR = the number of air corridors covered by air defense systems in this sector.

Operational availabilities (OA_i) for air defense systems are given in tables 14 and 15. The terrain masking factor (TMASK) used in the Jiffy Game reprsents an average degradation expected in European type terrain and is assigned a value of .68. This value was determined by the Individual Engagement Model/ Sortie Effectiveness Model (IEM/SEM), a computer simulator that evaluates an attack helicopter's probability of surviving in specified air defense environment and also determines the helicopter sortie effectiveness against ground targets. Terrain masking data for the other types of terrain have not been evaluated. The battlefield geography together with the attack helicopter tactics being played determine the number of air corridors (NCORR) to be

covered by air defense systems in a sector. A maximum of five air corridors can be portrayed in the game. The assumptions that each air defense weapon can cover only one avenue of helicopter approach and that coverage by the entire array of air defense systems is evenly divided over all air corridors in the sector are made for the air defense combat methodology.

b. Number of engagements. The actual number of engagements by an air defense system against a given type of helicopter is computed by:

$$ENG_{ik} = EWPN_i \cdot WPCTL \cdot VIS \cdot S_i \cdot MNV \cdot \frac{NA_k}{\sum_{all\ k} NA_k} \qquad (7\text{-}27)$$

where, for the ith type AD weapon engaging the kth type helicopter with $EWPN_i$ as defined above:

ENG_{ik} = the number of engagements.

WPCTL = the AD weapon control factor.

VIS = the visibility degradation factor.

S_i = the suppression factor.

MNV = the degradation due to helicopter maneuvers.

NA_k = the number of helicopters.

The weapon control factor (WPCTL) applies to all air defense systems in the sector and modifies their capabilities for engaging enemy helicopters in consideration of such factors as the presence of friendly aircraft in proximity to the battle area. Table 48 gives the weapon control status factors for the air defense systems along with the criterian for determining the appropriate factor for the gaming situation. The visibility degradation factor (VIS) is as given in table 11, and suppression factors for air defense weapons can be determined from tables 12 and 13. The helicopter maneuver factor (MNV) accounts for the decreased capability of an air defense weapon to successfully engage a helicopter carrying out evasive maneuver tactics. A value of .9 has been assigned to this parameter based on the SCORES "Jiffy" War Gaming Methodology (reference 5). AD weapons guided by infrared sensors; e.g., Redeye, Stinger, SA-7, and SA-9, are susceptible to frequent losses of IR lockon opportunities. To account for this, the number of engagements for these systems is degraded by a factor of .7, a value again documented in the SCORES "Jiffy" War Gaming Methodology (reference 5). In addition, when the infantry is mounted, only 1/3 of the hand-held AD weapons are considered able to be fired. Distribution of air defense engagements to the different helicopters is directly proportional only to the helicopter configuration of the cell and is accounted for in equation 7-27 by the ratio $\frac{NA_k}{\sum_{all\ k} NA_k}$. This distribution

Table 48. Air defense weapon control factor.

Status	Description	Value
Free	Accounts for late detections, shots outside performance boundaries	.9
Hold	Friendly aircraft in area, fire on command only	.7
Tight	Self-defense only	.1

SOURCE: SCORES "Jiffy" War Gaming Methodology, July 1975, p. 74.

scheme arises from the assumption that AD systems cannot distinguish among different types of helicopters when engaging a heterogeneous cell.

c. Helicopter losses. The general assessment equation, equation 7-1, as formulated to compute helicopter losses is:

$$ACKILL_k = \left\{1 - \prod_{\text{all } i} \left(1 - \frac{SEKP_{ik}}{NA_k}\right)^{ENG_{ik}}\right\} \cdot NA_k \qquad (7\text{-}28)$$

where, for the ith type AD weapon engaging the kth type helicopter with NA_k and ENG_{ik} as defined above:

$ACKILL_k$ = the number of helicopters killed.

$SEKP_{ik}$ = the single engagement kill probability.

The single engagement kill probabilities ($SEKP_{ik}$) for AD systems firing against helicopters are classified and contained in table B-8 of the classified data appendixes (part 2). For unclassified presentations, a value of .1 has been assigned to all SEKPs. It should be noted that the effect of electronic countermeasures (ECM) is reflected in the SEKP value entered into the assessment equation; that is, the ECM environment for the AD weapons provides an index for extracting appropriate SEKP values from the table. The outcome of equation 7-28 represents the total number of a given type helicopter killed by all opposing AD weapons. To provide more specific results at the conclusion of the assessments, the number of helicopters killed by each different AD system is determined by an apportionment algorithm expressed algebraically as:

$$KILL_{ik} = \frac{1 - PK_{ik}}{\sum_{\text{all } i} (1 - PK_{ik})} \cdot ACKILL_k \qquad (7\text{-}29)$$

where, for type i AD firers against type k helicopters:

$KILL_{ik}$ = the number of helicopters killed by firer.

$ACKILL_k$ = the total helicopters killed.

$1 - PK_{ik}$ = the probability that the firer killed the helicopter, where:

$$PK_{ik} = \left(1 - \frac{SEKP_{ik}}{NA_k}\right)^{ENG_{ik}} \qquad (7\text{-}30)$$

with $SEKP_{ik}$, NA_k, and ENG_{ik} as defined above.

3. Armed helicopter assessments. Armed helicopter assessments are made against all front line ground systems in the opposing force array.

a. Targetable weapons. The following equation gives the number of weapon systems available for assessment:

$$TGT_k = (NW_k \cdot OA_k - LOSS_k) \cdot ACQ \cdot VIS \cdot PSN \qquad (7\text{-}31)$$

where, for the kth type ground weapon system:

TGT_k = the number of targetable weapon systems.

NW_k = the number of weapons in the initial force arrays.

OA_k = the operational availability.

$LOSS_k$ = the number of weapons lost in previous assessments (cumulative).

ACQ = an acquisition percentage factor.

VIS = a visibility degradation factor.

PSN = the tactical deployment factor.

The operational availabilities (OA_k) for all targeted weapon systems are given in tables 14 and 15. The acquisition factor (ACQ) is the probability that a target will be reacquired by an attack helicopter during the attack run, subsequent to its initial detection. Based on the SCORES "Jiffy" War Gaming Methodology (reference 5), the value of this parameter is set to .9 for attacking targets and .7 for defending targets. Visibility degradation factors (VIS) are given in table 11 and the tactical positioning factors (PSN) are found in table 19 for the attacking and defending forces.

b. Fire distribution factors. The proportion of the helicopter fire allocated to a particular type of target is computed by:

$$FDF_k = \frac{FPS_k \cdot (NW_k \cdot OA_k - LOSS)}{\sum_{\text{all } k} FPS_k \cdot (NW_k \cdot OA_k - LOSS_k)} \qquad (7\text{-}32)$$

where, for the kth type targeted weapon system with NW_k OA_k, and $LOSS_k$ as defined above:

FDF_k = the fire distribution factor.

FPS_k = the firpower score of the weapon.

The classified firepower scores (FPS_k) are contained in table B-1 of the classified data appendixes, part 2; unclassified firepower scores used for unclassified processing are given in table 1. Since certain air defense systems are located within front line maneuver units, they are included in the target array for helicopters. Due to the AD threat, helicopters may desire a higher priority for firing at targetable AD weapons than would be realized in a straightforward application of equation 7-32. If so, the amount of helicopter fire directed against AD systems is increased by multiplying their firepower scores, during application of equation 7-32, by an appropriate factor from 1 to 10, which adjusts their computed fire distribution factors.

c. Rounds expended. For each type of ordnance, the number of rounds fired during a pop-up is calculated by:

$$ROUNDS_{oki} = POPORD_{oi} \cdot NA_i \cdot SH_i \cdot FDF_k \qquad (7\text{-}33)$$

where, for the oth type ordnance fired by type i helicopter at type k targets with FDF_k as defined above:

$ROUNDS_{oki}$ = the total number of rounds fired.

$POPORD_{oi}$ = the number of rounds per pop-up fired by a helicopter.

NA_i = the number of helicopters in the cell.

SH_i = the helicopter suppression factor.

For each type of helicopter, the rounds of each type expended per pop-up (POPORD) is the ratio of the total rounds of that type in the ordnance load from table 46 to the total pop-ups needed to expend its entire ordnance load as computed by equation 7-25. The helicopter suppression factor (SH_i) is determined in accordance with paragraph 6.

d. Ground losses. The general assessment equation as applied to helicopter assessments of ground forces is:

$$GFKILL_k = \left\{1 - \prod_{\text{all } i} \prod_{\text{all } o} \left(1 - \frac{SSKP_{ok}}{TGT_k}\right)^{ROUNDS_{oik}}\right\} \cdot TGT_k \qquad (7\text{-}34)$$

where, for ordnance type o fired by type i helicopters against type k targets with TGT_k and $ROUNDS_{oik}$ as defined above:

$GFKILL_k$ = the number of targets killed.

$SSKP_{ok}$ = the single shot kill probability.

The single shot kill probabilities ($SSKP_{ok}$) for helicopter weapons are classified and contained in table B-9 of the classified data appendixes, part 2. For unclassified processing, the value of .5 has been assigned to this parameter. The target posture is one index needed to enter the helicopter SSKP table. Consequently, the actual SSKP value used in equation 7-34 is a weighted average of two values extracted from the table. The methodology for determining the correct SSKP is exactly the same as found in the discussion of armor/antiarmor combat assessments, paragraph 7d(3). The helicopter assessment equation, like others previously described, computes the total number of targets killed by all helicopters. To obtain more detailed killer-victim statistics, this total is apportioned among the different types of helicopters involved by the following equation:

$$KILL_{ik} = \frac{1 - PK_{ik}}{\sum_{\text{all } i} (1 - PK_{ik})} \cdot ACKILL_k \qquad (7\text{-}35)$$

where, for type i helicopters firing at type k targets with $ACKILL_k$ as defined above:

$KILL_{ik}$ = the targets killed by helicopters.

$1\text{-}PK_{ik}$ = the probability the helicopters killed the target, where:

$$PK_{ik} = \prod_{\text{all } i} \left(1 - \frac{SSKP_{ok}}{TGT_k}\right)^{ROUNDS_{oik}} \qquad (7\text{-}36)$$

for $SSKP_{ok}$, TGT_k, and $ROUNDS_{oik}$ as defined above.

It should be observed that this apportionment accounts for those targets killed by all the different types of ordnance the helicopter carried.

(f) Personnel casualties. The only personnel casualties produced by air defense assessments are the crew losses associated with the helicopters that are killed. No infantrymen are killed in conjunction with helicopter losses since troop carrier aircraft are not included in the Jiffy Game weapon array. Casualties to both mounted and dismounted infantry personnel together with associated weapons/materiel are incurred during helicopter assessments against ground forces. Dismounted infantry personnel are directly targeted for attrition by helicopter fire, while mounted infantry casualties are based on the losses incurred by armored personnel carriers (APCs). The methodology for determining mounted infantry casualties, all infantry weapon/materiel kills, and crew losses has been set forth in paragraph 7d(3)(c) and is directly applicable to the attack helicopter/air defense combat assessments.

(g) Ammunition expenditure. The consumption of ammunition by air defense systems is not considered in the Jiffy Game methodology since TACAIR, a primary air defense target, is played external to this game. Ordnance supplies never restrict helicopter engagement capability, and no accounting is kept of the number of rounds expended as assessments are made. For attack helicopters, ammunition loads do determine the effectiveness of the aircraft against the opposing force. The primary defining characteristic for each type of helicopter is the ordnance configuration, from table 46, which in turn determines the number of pop-ups required for that aircraft to complete a sortie. The number of rounds fired by helicopters is accumulated in an ammunition consumption array to be provided as part of the results of the game.

(6) TACAIR assessments. Although the CACDA "Jiffy" war gaming process considers both attacks by and defense against tactical aircraft (TACAIR), no assessments of combat involving TACAIR units are made by the automated Jiffy Game. Casualties incurred during TACAIR attack missions are assessed by a separate automated game known as TACCOM, developed and run by the US Air Force Tactical Fighter Weapons Center (USAFTFWC) (see reference 6). However, tactical aircraft can be entered into the Jiffy Game weapon system arrays so that their firepower scores are included in the rate of advance calculations. Also, the losses resulting from TACAIR combat, as determined by the TACCOM model, can be added to the losses resulting from the Jiffy Game combat assessments so that they are apportioned to units on the force file in accordance with the procedure described in paragraph 8.

8. LOSS APPORTIONMENT.

a. General. The Jiffy Game assessment methodologies determine the numbers of weapon systems lost in combat by each major force. These cumulative combat losses must then be distributed among the individual units in each force. This loss apportionment process is done after all the Jiffy Game combat attrition has occurred and has provisions to apportion losses to tactical aircraft (TACAIR). Since losses to TACAIR are assessed against relatively few units, the losses to TACAIR are apportioned separately from the Jiffy Game combat losses, and they are apportioned first.

b. Combat Intensity Levels. The number of weapon systems lost by each unit is based on a qualitative factor, which is an indicator of the intensity of combat in which the unit has been engaged. Six of these combat intensity levels have been defined as shown in table 49. As can be seen in the table, each combat intensity level has an apportionment factor associated with it. This factor denotes the portion of the weapon systems in the unit that are subject to the loss apportionment. It should be noted that if a unit is specified as being hit by TACAIR, not only is it subject to TACAIR apportionment but it is also considered for the apportionment of the Jiffy Game combat losses as a unit in the main battle area.

Table 49. Combat intensity levels.

Description	Apportionment Factor
Uncommitted unit	.001
Unit beyond direct fire	.20
Reserve unit committed late	.50
Unit on perimeter of main battle area	.75
Unit in main battle	1.00
Unit hit by TACAIR	1.00

c. Loss Apportionment Algorithm. The number of weapon systems attrited in each unit is a function of the number of a given type of weapon systems lost, the number of that type of weapon systems in a particular unit, and the combat intensity level of the unit. The number of a given type of weapon systems lost in any particular unit is expressed by the algorithm:

$$NA_{ik} = \frac{N_{ik}\, NL_k}{CIL_i\, D_k} \qquad (8\text{-}1)$$

where, for the kth type of weapon systems and the ith unit:

NA_{ik} = the number of the weapon systems lost by the unit.

N_{ik} = the number of weapon systems in the unit.

NL_k = the total number of the weapon systems lost to the force.

CIL_i = the combat intensity level of the unit.

D_k = the total number of the weapon systems in the force which are subject to loss apportionment and is expressed by:

$$D_k = \sum_{\text{all } i} \frac{N_{ik}}{CIL_i} \qquad (8\text{-}2)$$

where, D_k, N_{ik} and CIL_i are as defined above.

Note that for this apportionment process to be valid, the total kth type weapon systems in a force subject to loss apportionment (D_k) must be greater than the number of the kth type weapon systems lost by a force (NL_k). Also note that if losses to TACAIR are apportioned to a force, the total number of kth type weapon systems in the force subject to apportionment of the Jiffy Game combat losses (D_k[JG]) must be reduced by the number of the kth type weapon systems lost to TACAIR NL_k (TACAIR). Or in other words:

$$D_k\,[JG] = D_k - NL_k\,(TACAIR) \qquad (8\text{-}3)$$

The apportionment algorith is used to apportion infantry casualties, their associated materiel losses, and crew-served weapon losses. The personnel lost with the crew-served weapons are calculated, not apportioned. The calculation is identical to that used for the determination of crew losses (paragraph 7d(4)(c)).

9. UNIT EFFECTIVENESS. The ability of a unit to perform its mission in combat is a qualitative assessment known as a unit's combat effectiveness. This measurement is difficult to quantify due to the number of intangible factors that affect it. Among these are troop morale, fatigue, leadership and the number of personnel and equipment operational in the unit. The Jiffy Game computes a measure of the firepower remaining in a unit relative to the amount of firepower initially contained in the unit. This measurement is known as the unit effectiveness. The unit effectiveness is determined by equation 9-1.

$$UEFF_j = \frac{\sum_{\text{all } i} (N_{ij} \, FPS_i)}{ITFPS_j} (100) \qquad (9\text{-}1)$$

where, for the ith weapon systems of the jth unit:

$UEFF_j$ = the unit effectiveness.

N_{ij} = the number of weapons in the unit.

FPS_i = the firepower score of the weapon.

$ITFPS_j$ = the initial total firepower score of the unit at 100 percent strength.

The effectiveness of each unit is computed at the creation of the unit and updated in accordance with equation 9-1 each time losses are apportioned to the units.

10. RETURN TO DUTY CRITERIA. The Jiffy Game calculates the portions of weapon systems lost in combat that are recoverable and nonrecoverable. The nonrecoverable losses are those weapon systems assumed to be destroyed or not able to be recovered due to adversities of terrain or tactical situation. The recoverable weapon systems are those accessible and repairable.

a. Three levels of repair for Blue weapon systems are considered in the Jiffy Game.

(1) Division repair - used on equipment that is repairable with divisional maintenance support elements. Divisional mean time to repair is considered to be 2 days.

(2) COSCOM repair - used on equipment that is repairable with non-divisional direct/general support (DS/GS) maintenance level assets. Non-divisional DS maintenance is taken to be able to perform maintenance in either DISCOM or COSCOM areas. Mean time to COSCOM repair is taken as 5 days.

(3) Exceeding theater repair - combat damaged equipment that exceeds the in-country maintenance capability or capacity. Repair time is considered to be extensive. Table 50 contains expected percentages of recoverable and

Table 50. Battlefield equipment recovery and repair percentage matrix (Blue only).

	Threat			
	Indirect Fire		Direct Fire	
	Combat Posture		Combat Posture	
	Atk	Def	Atk	Def
Tanks				
Non-Recoverable	8	31	11	44
Recoverable	92	69	89	56
Div Repair	56	35	32	24
COSCOM Repair	33	49	21	28
Exceeds Theater Repair	11	16	47	48
Carrier, ARAAV				
Non-Recoverable	10	33	13	44
Recoverable	90	67	87	56
Div Repair	52	24	32	21
COSCOM Repair	26	50	19	28
Exceeds Theater Repair	22	26	49	51
Field Artillery & Air Defense Arty				
Non-Recoverable	8	13		
Recoverable	92	87		
Div Repair	52	29		
COSCOM Repair	32	49		
Exceeds Theater Repair	16	22		

SOURCE: Battlefield Equipment Recovery and Repair Variable Percentage Matrix, US Army Ordnance Center, p. B-2.

nonrecoverable weapon losses for categories of Blue weapon systems by combat posture and type of fire encountered. The recoverable percentages are subdivided for losses repairable at division, COSCOM, and those that exceed theater repair capabilities.

b. The return to duty criteria for Red weapon systems are classified and may be found in part 2, appendix B, table B-9. Three levels of repairability are considered in the Jiffy Game for Red recoverable weapon systems:

- Light - requires 2 days to repair.
- Medium - requires 5 days to repair.
- Major - requires 10 days to repair

Table 51 contains a set of unclassified Red return-to-duty criteria developed for unclassified processing and documentation purposes.

Table 51. Red equipment repairability.

Level of Repairability	Days to Repair	Percent Damaged
Recoverable:		
Light	2	40
Medium	5	30
Major	10	20
Nonrecoverable	--	10

NOTE: See table B-9 in part 2 of this report for classified Red equipment repairability values.

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This report is one of a set of three reports produced to document the combat assessment methodologies and automated features of the CACDA Jiffy war gaming process, developed to support TRADOC SCORES scenario development and force evaluation efforts. Part 1 of this report contains the methodologies used in the automated routines of the Jiffy Game and their unclassified data base. Part 2 presents the classified Jiffy Game data base and the sources from which the data were extracted or derived. The other two reports in this set are the CACDA Jiffy War Games Programmers Manual and the CACDA Jiffy War Game Users Manual

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